PROCEEDINGS
OF THE
THIRTY-SEVENTH
DIAN SCIENCE CONGRESS
POONA, 1950

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OFFICIAL MATTERS

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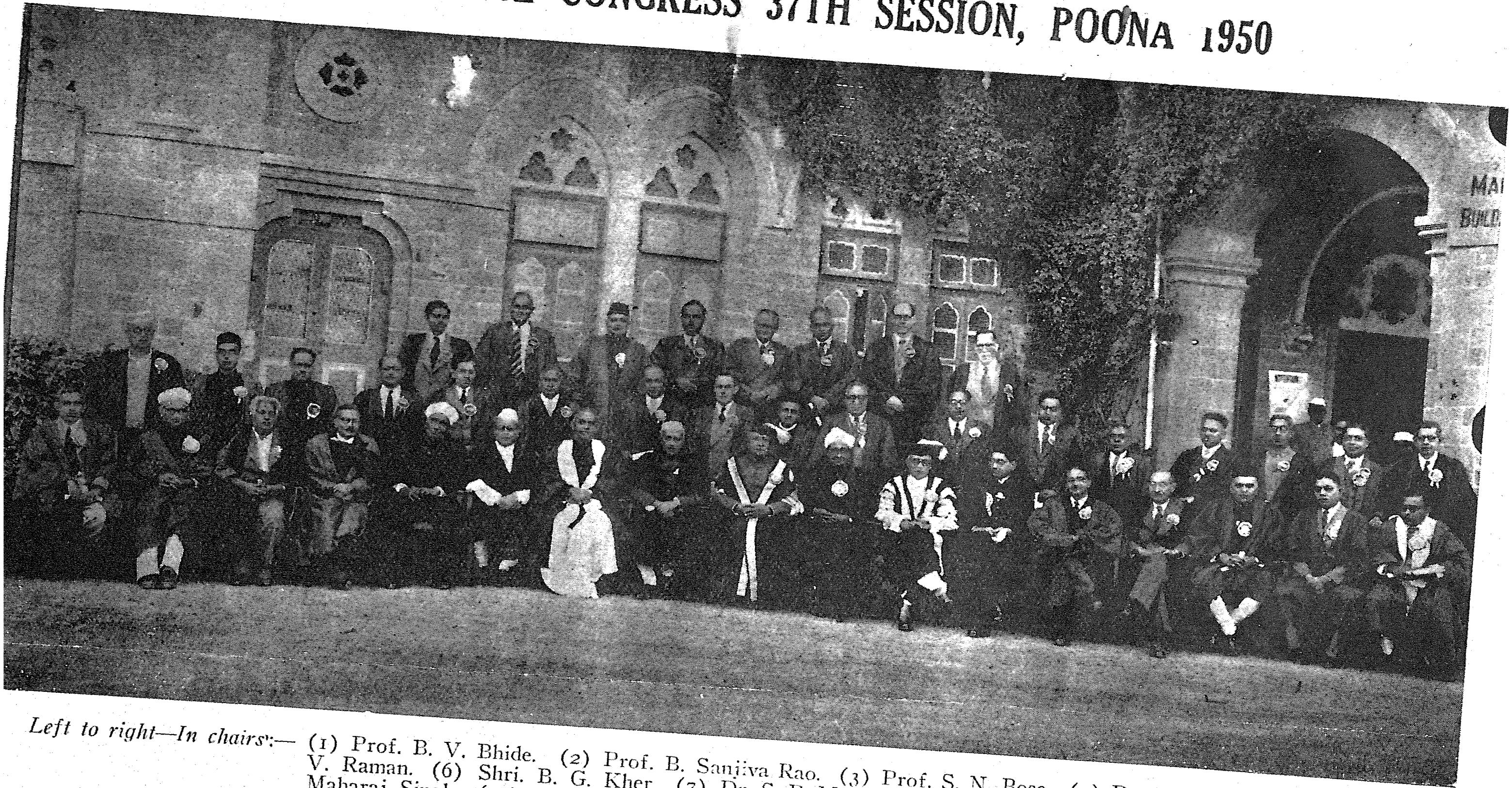
INDIAN SCIENCE CONGRESS 37TH SESSION, POONA 1950



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Dr. C. Von Furer Haimendorf	*Convener*
Mr. Gautam Shankar Roy	*Recorder*
Dr. S. S. Sarkar	*Sectional Correspondent*
Prof. H. D. Sankalia	*Local Sectional Secretary*
Dr. S. K. Basu	*Elected Members*
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Prof. P. C. Mahalanobis	*Past Presidents who are either Ordinary or Honorary Members*
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Dr. B. S. Guha	
Prof. K. P. Chattopadhyay	
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*Mr. T. C. Das	
Dr. N. P. Chakravarti	
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Prof. N. V. Joshi	

Rao Bahadur Y. Ramanatha Ayyar	
Rai Bahadur Kalidas Sawhney	
Mr. N. L. Dutt	
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Dr. B. L. Chona	
Dr. S. P. Ray Chaudhuri	
Mr. P. C. Raheja	

11. Physiology—

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Dr. D. P. Sadhu	*Sectional Correspondent*
Dr. R. Vethavanam	*Local Sectional Secretary*
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Prof. W. Burridge	*Past Presidents who are either Ordinary or Honorary Members*
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Dr. B. B. Dikshit	
Rao Bahadur B. T. Krishnan	
Prof. B. Narayana	
*Prof. S. N. Mathur	
*Dr. B. Mukerji	
Prof. P. De	
*Prof. S. A. Rahman	
*Dr. Bashir Ahmad	
Prof. B. B. Sarkar	
Dr. K. P. Basu	*Past Recorders who are either Ordinary or Honorary Members*
Mr. B. Chatterji	
Prof. Khem Singh Grewal	
Mr. M. L. Chatterjee	
Prof. G. K. Ghosh	
Mrs. Kamala Sawhney	
Prof. N. P. Benawari	

12. Psychology and Educational Sciences—

Prof. Kali Prasad	*Convener*
Mr. L. J. Bhatt	*Recorder*
Mr. S. C. Bisi	*Sectional Correspondent*
Mr. B. V. Bapat	*Local Sectional Secretary*
Mrs. Santa Deb	*Elected Members*
Mr. Samiran Banerjee	

Mr. N. S. N. Sastry	*Past Presidents who are either Ordinary or Honorary Members*
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Mr. J. M. Sen	
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Prof. H. P. Maiti	
Dr. I. Latif	
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Prof. B. L. Atreya	
*Dr. B. Kupuswamy	
*Dr. Indra Sen	
Dr. Zakir Hussain	
Mr. P. S. Naidu	
Prof. T. K. N. Menon	
Mr. S. K. Bose	*Past Recorders who are either Ordinary or Honorary Members*
Mr. Pars Ram	

13. Engineering and Metallurgy—

Dr. D. R. Malhotra	*Convener*
Mr. J. Dutt	*Recorder*
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Prof. A. Desouza	*Local Sectional Secretary*
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Mr. H. P. Bhaumik	
*Mr. N. Sen	
Prof. M. Sen Gupta	
Prof. H. L. Roy	*Past Recorders who are either Ordinary or Honorary Members*
Dr. S. K. Sarkar	
Dr. J. Ganguly	

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1-4. President, two General Secretaries and Treasurer (*ex-officio*).
5-17. Sectional Presidents of 13 Sections.

18. Dr. S. P. Agharkar (Poona).
19. Dr. K. N. Bagchi (Calcutta).
20. Prof. H. J. Bhabha (Bombay).
21. Dr. C. G. Pandit (Delhi).
22. Dr. Gilbert J. Fowler (Bangalore).
23. Dr. B. C. Guha (Calcutta).
24. Prof. D. D. Kanga (Madras).
25. Prof. H. P. Maiti (Patna).
26. Dr. H. K. Mitra (Jamshedpur).
27. Dr. K. Motwani (Adyar).
28. Prof. M. N. Saha (Calcutta).
29. Rai Bahadur K. D. Sawhney (Bom.)
30. Rai Bahadur J. M. Sen (Cal.) (*Convener*).
31. Sir S. S. Sokhey (Bombay).
32. Dr. A. C. Ukil (Calcutta).
33. Dr. D. N. Wadia (New Delhi)

4. LOCAL RECEPTION COMMITTEE

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His Excellency Raja Maharaj Singh, Governor of Bombay.

VICE PATRON

Lt. General Maharaj Shri Rajendrasinhji, D.S.O., G.O.C., in Chief. H. Q. Southern, Command, Poona.

CHAIRMAN

Rt. Hon'ble Dr. M. R. Jayakar, P.S., D.C.L., LL.D., Vice-Chancellor, University of Poona, Poona 3.

VICE-CHAIRMAN

D. V. Vyas, Esqr., I.C.S., Commissioner, Central Division, Poona 1.

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S. V. Chandrasekhar Aiya, Esqr., M.A. (Cantab) B.Sc., A.M.I.E.E., Sen.M.I.R.E., 'Apka', Apte Road, Poona 4.

TREASURERS

Dr. V. N. Bhave, M.B.B.S., Near Peru-Gate, Sadashiv Peth, Poona 2.
Dr. D. D. Karve, M.Sc., Ph.D., Principal, Ferguson College, Poona 4.

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Major E. Benjamin, D.P.H.
Col. S. K. Bose,
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M. R. Yardi, Esqr., I.C.S.,

5. ARRANGEMENTS FOR THE THIRTY-SEVENTH SESSION

The Local Reception Committee made all local arrangements necessary for the transaction of the scientific works of the session as well as for accomodation of the members and delegates who attended the session.

6. LIST OF DELEGATES

Great Britain
Sir. Robert Robinson, (N.L.).
Lady Robinson.
Prof. J. D. Bernal.
Dr. Walter Zander.
Dr. Harold Fisher.

Sweden
Prof. O. E. H. Rydbeck.
Prof. Herman Wold.

Canada
Dr. M. L. Miller.

America
Dr. E. U. Condon.
Dr. Herman Mark.
Prof. A. H. Compton (N. L.).
Prof. Marshal Stone.
Prof. S. Trone.

France
Madam Irene Joliot Curie, N.L.
Prof. Fredric Joliot, N.L.
Prof. P. Auger.
Dr. & Mrs. Brumpt.

Russia
Prof. D. Englehardt.
Dr. Butrov.

Learned Societies.

All India Dental Association	Dr. R. Ahmed. Dr. V. M. Desai. Dr. K. L. Shourie. Dr. M. K. Patel. Dr. N. N. Bery. Dr. S. K. Majumdar.
Calcutta Mathematical Society	Prof. M. R. Siddiqi. Prof. F. W. Levi. Dr. N. G. Shabde. Dr. S. K. Chakraborty. Mr. S. Gupta.
Entomological Society of India	Dr. K. S. Pruthi. Dr. S. Pradhan.
Indian Botanical Society	Prof. G. P. Majumdar. Prin. Y. Bharadwaja. Dr. T. S. Mahabale.

Indian Research Fund Association	Dr. C. G. Pandit.
The Institute of Engineers (India)	Shri A. N. Khosla. Shri J. Dutt. Dr. D. R. Malhotra. Shri K. B. Ray. Shri J. Ganguly. Shri R. Sahaya. Shri H. S. Batliwala. Shri M. L. Champehkar. Shri K. T. Divecha. Shri S. B. Joshi. Rao Bahadur N. S. Joshi. Khan Bahadur Framroz D. Mehta.
National Institute of Science of India, Delhi.	Prof. S. N. Bose.
National Nutrition Association of India	Prof. V. Subrahmanyan. Prof. G. Sankarar.
Royal Asiatic Society of Bengal	Dr. A. C. Ukil. Dr. K. N. Bagchi. Dr. K. Biswas. Dr. S. K. Mitra. Dr. J. L. Bhaduri. Dr. Meghnad Saha. Prof. J. M. Sen.

Universities.

Aligarh Muslim University—Aligarh	Mr. Shamim Ahmed. Dr. N. M. Basu. Mr. Omar Ali Siddiqi. Dr. M. A. H. Qadri. Dr. M. A. Basir Khan. Mr. Jamil Ahmed Siddiqi.
Andhra University—Waltair	Prof. C. Mahadevan. Mr. C. Venkata Rao.
Baroda University—Baroda	Dr. C. S. Patel. Dr. D. V. Gogte. Mr. L. J. Bhatt.
Banares Hindu University—Banares	The Pro. Vice-Chancellor, B. H. U. The Principal, College of Science. The Principal, College of Technology The Principal, College of Agriculture. The Principal, College of Mining and Metallurgy. The Principal, Engineering College. The Principal, Central Hindu College.
Calcutta University—Calcutta	Prof. S. N. Bose. Mr. S. K. Bose. Dr. D. Chakravarty. Prof. P. C. Sarbadhikari. Dr. P. K. Bose. Mr. N. K. Nande. Mr. Gautam Sarkar Ray.

	Dr. S. P. Ray Choudhury. Dr. B. C. Halder. Prof. J. M. Sen. Dr. B. B. Sarkar.
Nagpur University—Nagpur	Dr. M. A. Moghe. Shri K. Sripada Rao. Dr. A. N. Kappanna. Dr. V. B. Shukla. Dr. M. C. Nath. Shri S. Mookerji.
Osmania University— Hyderabad, Dn., ..	Dr. J. C. Kameswar Rao. Dr. Syed Husain Zahir. Dr. Syed Husain. Dr. B. K. Das.
Madras University—Madras	Dr. M. A. Govinda Rao. Dr. C. P. Gnanamuthu. Dr. S. P. Sarma. Dr. U. R. Erhenfels. Dr. T. S. Sadasivan. Shri D. V. Rajalakshman.
Rajputana University—Jaipur	Dr. Dayal Krishna.
Travancore University—Trivandrum ..	Dr. C. S. Venkateswaran. Dr. K. Bhaskaran Nair. Dr. A. Abraham. Dr. S. S. Pillai. Shri A. Venkitachalam Aiyar. Shri R. Ramachandra Aiyar. Shri E. I. George. Shri. M. C. Abraham. Miss Aleyamma George. Miss Mary John. Shri N. Krishna Pillai.

RESEARCH INSTITUTIONS AND COLLEGES

Ferguson College—Poona	Prof. R. V. Barve. Prof. K. V. Kelkar. Prof. V. V. Apte. Prof. G. L. Chandratreya. Prof. B. G. Shirole. Prof. D. D. Vadekar. Dr. K. K. Dole.
Forest Research Institute and College, —Dehra Dun	Dr. D. Narayanamurti.
Gaya College—Gaya	Mr. N. C. Agarwala.
Geological Survey of India—Calcutta ..	Dr. W. D. West. Dr. J. B. Auden. Dr. A. K. Dey.
The National Academy of Science, Allahabad	Prof. H. R. Mehra. Prof. D. R. Bhattacharya.

	Prof. Shri Ranjan.
	Prof. N. R. Dhar.
	Prof. A. C. Banerji.
	Dr. P. L. Shrivastava.
	Prof. Ram Behari.
	Dr. Ram Kumar Saksena.
Zoological Survey of India, Calcutta ..	Dr. S. L. Hora.
	Dr. B. S. Chauhan.
	Dr. A. P. Kapur.

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	Major General H. Williams.
	Major General A. N. Sharma.
	Brigadier H. G. Parcell.
	Dr. R. S. Thakur.
	Col. N. N. Chopra.
	Lt. Col. P. L. Kapur.
	Lt. Col. B. N. Mitra.
	Dr. T. S. Subramaniam.
	Col. C. C. Kapila.
	Lt. Col. O. P. Varma.
	Lt. Col. J. L. Duff.
	Mr. C. V. S. Sastry.
	Mr. G. De.
	Brigadier R. E. Holloway.
	Col. A. Campbell Harris.
	Mr. B. B. Chaudhury.
	Major General D. R. Thapar.
	Mr. K. K. Framji.
	Mr. C. C. M. Broughton.
	Mr. J. G. Keswani.
	Mr. S. J. Shahaney.
	Capt. W. J. Saxton.
	Captain Daya Shanker.
	Captain Superintendent H. M. I. Dockyard, Bombay.
	Group Captain D. N. Chakravarti.
	Group Captain Atma Ram.
	Dr. D. S. Kothari.
	Dr. Sohan Lal.
	Dr. R. S. Varma.
	Dr. N. B. Bhatt.
	Dr. Haripada Nath.
	Dr. Sampooran Singh.
Ministry of Education, Govt. of India, New Delhi	Mr. G. K. Chandiramani.
	Dr. P. D. Shukla.

Dept. of Scientific Research, Govt. of India, New Delhi.	Dr. S. S. Bhatnagar. Mr. T. Gansalves.
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Ministry of Industries and Supply, Govt. of India, New Delhi.	Dr. J. C. Ghosh. Dr. J. N. Ray.
Govt. of Assam	Shri P. C. Chowdhury.
Govt. of United Provinces, Dept. of Economics & Statistics	Shri J. K. Pande.
Govt. of Orissa, Dept. of Development, Cuttack	Shri P. B. Brahma.

COMMERCIAL BODIES

Bengal Nagpur Railways	Shri S. A. Yusoof. Shri Sudarshanlal.
Federal Public Service Commission, New Delhi	Mr. G. C. Chatterjee.

7. PROGRAMME OF THE SESSION

The Thirty-Seventh Session of the Indian Science Congress was held at Poona under the auspices of the Poona University from January 2 to 8, 1950.

The inaugural meeting was held on Monday, January 2, 1950 in a Pandal erected for the purpose in the Fergusson College grounds, Poona, in the presence of a large number of delegates, members and visitors. The presence of foreign Scientists from Great Britain, Canada, America, Sweden, Frances and Russia was a special feature of this session of the Congress.

Dr. M. R. Jayaker Vice-Chancellor, University of Poona, as chairman of the Local Reception Committee welcomed the delegates and members and requested Hon'ble Dr. Shyama Prasad Mookerjee Minister-in-charge of Industries & Supplies, Govt. of India to open the Congress. Hon'ble Dr. Mookerjee delivering a short speech declared the proceedings open. After the speech of Hon'ble Dr. Mookerjee, the President, Prof. P. C. Mahalanobis delivered his address. After the Presidential address, Prof. P. C. Mahalanobis, requested Hon'ble Pandit Jawharlal Nehru, Prime Minister, Govt. of India, to say something before the vast gathering. The Hon'ble Pandit Jawharlal Nehru then addressed the members and guests of the Indian Science Congress. The meeting terminated with a vote of thanks to Nehru, Hon'ble Dr. Shyama Prasad Mookerjee and other distinguished visitors and patrons proposed by Dr. B. Sanjiva Rao, one of the General Secretaries.

8. OPENING PROCEEDINGS

Rt. Hon'ble Dr. M. R. Jayakar, Vice-Chancellor of University of Poona and Chairman of Local Reception Committee welcomed the members and delegates with the following Speech.

Welcome Speech:

Your Excellency, Pandit Jawharlal Nehru,
Ladies & Gentlemen,

It is my proud privilege this afternoon to tender you all a cordial welcome on behalf of this young University. I call the University young, but it may be noted that it is planted in and caters for the requirements of a city which is very ancient in its educational, cultural and political attainments. Poona was made a capital town of the Marhatta territory more than 200 years ago, and since then it has held its position even under British rule. In the days of the Maratha rulers it used to be the centre, not only of political power, but also of culture and learning. Some historians record that the Maratha rulers used to hold every year conferences of learned men gathered from all over India and distribute as rewards for learning amounts which often ran to 18 lakhs, equal to £140,000 a year. This session of the Indian Science Congress, therefore, can be said to be carrying on the traditions of these learned conferences, and I hope the results will be equally fruitful.

This is a great day in the annals of this young University. The University feels very grateful that, inspite of its infancy, you should have responded to its call to assemble here this time. It is a great gathering of unique value. Present in our midst are most distinguished persons from different parts of the world, amongst whom figure prominently Sir Robert Robinson, F.R.S., Dr. A. H. Compton of great reputation in the development of atomic energy, Madame Joliot-Curie of great fame, Professor Frederic Joliot, Professor Bernal and many others of great eminence in the scientific world. Likewise, there are present on this occasion men distinguished in the present administration of the country, Pandit Jawharlal Nehru, the Prime Minister of India, whose love for scientific achievements are well known, and I beg to associate myself with comments which the Bombay Premier has made in that connection. There are, besides, Dr. Shyama Prasad Mookerjee, a member of the present Cabinet of the Government of India, an intimate friend with whom I had the pleasure of working on another platform for many years, and Professor Mahalanobis, whose reputation as a statistician has preceded his visit to this city. We feel it a great honour to welcome them. The Premier of Bombay has very kindly mad it convenient to be present and speak on this occasion, for which we ar very grateful. Over all this assembly the popular Governor of Bomba His Excellency Raja Sir Maharaj Singh, presides, and we thank him f sparing the necessary time.

This University expects a great many things from this session of the Science Congress, therefore, can be said to be carrying on the traditions of Science Congress. To begin with, the young men of this University will have the pleasure of seeing in flesh and blood the great scientists who up to now have been mere names to them. I may mention that it is a tradition of Indian learning that contact should be established between the greatest men of the age and the young men who are aspirants after knowledge. In one of the books regarded as a holy scripture of India, it is recorded that, after a great seer had delivered an oration upon the merits of philosophy and learning, he was asked: "Can we see a great man, how he lives, how he walks, how he talks?" It appears to be a most natural desire of the young mind to see the great men of its age. That itself is a great education stirring them up to emulation. The sight therefore at this session of so many distinguished men will, I am sure, have very great effect upon the young men of this University.

We also hope that the papers that will be read and the lectures that will be delivered in your sectional meetings will throw light on many problems which are confronting educationists not only in India, but elsewhere in the world. This University has its problems also, and I devoutly hope that your discussions and your papers will throw light upon some of the main problems agitating the world, viz. how to bring scientific achievements into relation with the social requirements of the community. Science so far has achieved many things, but unfortunately its discoveries and inventions have been utilized, not for promoting social welfare but for purposes connected with the destruction of human life. Gradually a consciousness is growing that this must be stopped, and let us hope that your discussions at the sectional meetings will awaken the Professors and the students of this University to do their bit in diverting science towards the well-being of their generation.

Lastly come your popular lectures which the Indian Science Congress akes it a practice to deliver at every session. Our students are looking rward to great benefit by listening to these lectures, which will all be livered by experts in their own departments. If this has the effect of akening in the minds of our students the desire to learn more and more of science, the purpose of calling the session here will be partially achieved. Our students are yearning to see these distinguished men and listen to the words of instruction and advice which will fall from their lips or flow from their pen.

This University shares the general feeling in the country that the keynote of Indian progress is at present scientific advance. This sense is growing all over the country, because it is felt that the best way of achieving our present ideal, viz., to bring knowledge to the doors of the ordinary man, and to base his life on progressive advance, can only be achieved by the spread of scientific knowledge. There is great emphasis, therefore, laid to-day upon scientific instruction. The popular aspect of it forms one of the ideals and the aims of this University, for by the Act of its Incorporation the obligation has been laid on this University to spread knowledge all over the countryside and to bring it within the reach of those who cannot come to this University and profit by its corporate life or the instruction afforded here. This University, therefore, has already started on that mission, and it has held up to now several popular lectures delivered by experts for the benefit of the general public. It has also considered, through the report of a Special Committee, how the aspirations after academical instruction of those who, owing to employment elsewhere during the day or any other cause like insufficiency of resources, are unable to be present at the Colleges during the day, can be fulfilled. One such means has been suggested, viz., the creation of an external degree, the details of which are being worked out, and when complete, they will have the effect of drawing into the circle of University instruction all those who are unable to take advantage of the regular classes held here during the day. In support of this aspect of the University's activities, your popular lectures will be of very great value. It is realized that scientific advance cannot be achieved in isolation. India therefore desires to participate more and more intensively in the pool of international advance, making her own contribution from time to time. She realizes further that there must be an exchange of thought and effort with other countries of the world if she is to advance on proper lines. This University shares this view and hopes that the achievement of this ideal will be greatly helped by the session of the Indian Science Congress which is now being held here.

I welcome you all here on behalf of this University. We have planned a programme which, I hope, will enable you, in addition to your work, of delivering lectures or reading papers, to see Poona and its environments some of which are of great historical value. As I have stated before, Poona is an ancient city with many places of historical interest round about, created by Nature or by the industry of man. It will be a great pleasure for us to take you round to some of these places, and an intensive programme of excursions has been planned, of which I hope you will take full benefit.

This is our first effort to welcome and entertain a large and distinguished body like the Science Congress. It is not unlikely that you will come across some deficiencies. If so, may I hope that you will kindly overlook them?

After the Welcome address, Rt. Hon'ble M. R. Jayakar requested Hon'ble Dr. Syama Prasad Mookerjee, Minister-in-charge of Industries and Supplies Govt. of India to inaugurate the Thirty-seventh Session of the Indian Science Congress.

Hon'ble Dr. Mookerjee in declaring the Congress open delivered the following address:—

Mr. President & Fellow seekers of truth.

I deem it a privilege to have been invited to inaugurate the Annual Session of the Indian Science Congress. I accord a cordial welcome to all who are assembled here today, specially to the band of distinguished delegates who have come from abroad to participate in the deliberations of the Congress. During the last 37 years, the Indian Science Congress has grown from strength to strength and its great representative character today is an unmistakable evidence of the progress which India has achieved in the domain of science during the last half a century. A close association of distinguished foreign delegates with the Congress reveals the bond of unity that prevails in the field of science which knows no boundaries or geographical limits.

The historic city of Poona in and around which vibrate the memories of some of the proudest and the most valiant achievements of our ancestors is also a home of great cultural endeavours. It provides an appropriate setting for the Congress and will inspire all who are assembled here to face their responsibilities with courage and confidence.

The Annual Session of the Indian Science Congress serves as a yearly reminder to our scientists of the need for continuous dedication of scientific knowledge to the service of our motherland and of humanity at large. Such self-introspection is particularly necessary at this juncture of world history when the menace of atomic warfare hangs like a darkening cloud on the minds of all thinking men and women. An unanswered question is written across the future: Is man to be the master of the civilization he has created, or is he to be its victim? Can he control the forces which he has himself let loose? The only answer to it and the only way to counteract the threat is by a spiritual upsurge in the minds of common men and women in every country such as will compel the application of scientific knowledge towards the good of the world. Science, like religion, cannot be had in itself. It is the purpose and the social function which such knowledge serves that makes it good or bad. This view is not new to India. Indeed, this is the only view that has found favour with our sages and savants from ancient times. Our scientists are the inheritors of this age-old tradition and I have no doubt that they will never be a party to the utilisation of science for ignoble ends.

In speaking of the services of science it is usual in our country to dilate on the actual and potential contribution of scientific knowledge to the development of our agriculture and industry, and of our arts and crafts in war and peace. But I venture to think that the greatest contribution that science can make to the well-being of our country is by the inculcation of that attitude of mind, which for lack of a more expressive phrase is known as the scientific attitude towards life and its problems. The essence of this attitude lies in an inquisitive mind, not by any means of that of a narrow specialist, but of one that would ask questions and would not rest till it has found an answer to them. It shows itself in a diligent and an indefatigable search for facts, and when facts have been ascertained, in an objective study of their inter-relations. Valuation of facts thus determined and appraised is a subsequent process and must depend on one's individual moral judgment. An effective exercise of this judgment, however, becomes impossible unless the essential precondition of ascertaining facts and weighing them as objectively as possible has been fulfilled.

Nothing in this country impedes the application of scientific knowledge to the betterment of human beings or to the promotion of our agriculture and industry more than lack of this frame of mind. The great majority of our countrymen are still victims of ignorance and prejudice and are moved more often by set habits than by an objective analysis of the pros and cons of a particular course of action. As all scientists, social workers and administrators know, it is this conventional and passive attitude that offers the greatest resistance to the adoption of new habits and ways of living, new methods and practices in agriculture and new techniques and equipments in our unorganised industries which still constitute the major field of employment to our artisans and workers.

The gap between our scientific knowledge and its application to some of our current problems is as much a consequence as it is a cause of this lack of scientific attitude. To illustrate this argument I would deal separately with the application of scientific knowledge to our problems of public health and hygiene, agriculture and industry.

The laws of public health and hygiene are now so well-known and well established that it is a surprise to many observers not familiar with Indian conditions that they are so often honoured in their breach rather than in their observance not only in the countryside but also in urban areas. The problem is not merely one of organisation, equipment and finance but also of the creation of that inclination which alone can absorb the teachings of these laws and make them part of one's nature. It is not merely illiteracy, stupendous as that handicap is, that bars the door to most of our health reform; what blocks it effectively is the habit of mind born of centuries of suffering and inertia.

This applies to agriculture as well. It has been recognised during the last sixty or seventy years that one of the major problems of agricultural reform in this country is the extension of scientific knowledge from the laboratory to the field. Although some progress has been made in one or two particular lines, this basic problem of extension of scientific knowledge still remains unsolved.

The same mental attitude is a precondition for the effective application of the knowledge of science and technology to the problems of modern industry. Here, of course, the character of the problem somewhat changes; for by its very nature competitive industry can function in the long run only against the background of world development and no industrialist, however conservative, parochial or wedded to time-worn methods, can altogether ignore the results of science and technology. In this context science has therefore a much better chance to function but there are other problems connected with the application of science to industry which have to be tackled. One of them is the problem of co-ordination of scientific research as carried out in different institutions and the allocation of responsibility to them. There are four broad types of scientific institutes in our country, viz., Universities and other academic bodies; institutions of applied science; purely technological institutes, and lastly institutions supported by private industry. Is it possible to agree upon an appropriate allocation of research work to these institutes so that overlapping and duplication of efforts resulting in an unbalanced, lopsided development of scientific research in its different aspects may be avoided? In a vast country such as ours some duplication is unavoidable. Still, the need for a rational distribution of work among our scientific institutions is urgent specially in view of our limited resources in men, money and equipment. A body like the Indian Science Congress, embracing as it does all branches of science, can effectively deal with these issues of organisational policy, which in my judgment will not only influence the advancement of scientific knowledge in this country but also its effective application to problems of welfare.

Another question relates to the responsibility that naturally devolves on the present generation of our scientists to train up our young graduates of science, who may choose a scientific career for the high task that awaits them in future. One of the most outstanding achievements of the last half a century has been the tempo of scientific advance in this country and the quality of our scientific research inspite of many handicaps. We have built up a body of scientific men and women of which any country can be proud. Can our senior scientists assembled in this gathering assure us that this fine record will be maintained and even further strengthened in future? I am not unaware of the many handicaps and difficulties from which scientific institutions and research workers have suffered in the past. But inspite of all this, have our scientists done all in their individual capacity as teachers, directors or research officers, to supervise, help or encourage the junior investigators placed in their charge? Have they given of their best to their wards in the same way as they received the best from their masters in an earlier generation? I venture to pose this question before a representative forum like yours in the hope that the problem will receive your earnest consideration. If as a result of our deliberation you feel that scientific talent in this country is not receiving its due share of encouragement and support, or that the standard of work should be raised or that we are not guarding against the dangers of over-specialisation, it will be for you to contrive such measures as you consider necessary to remedy this state of affairs. Nothing would cause so lasting a damage to the prospects of scientific progress as the drying up of the springs of creative talent for want of encouragement or proper guidance.

India today stands at the cross-roads of history. She has attained her political independence after nearly two centuries of foreign rule. The problem of national reconstruction is perhaps more arduous and gigantic than the struggle for freedom itself. Millions of India's population are waiting to be served and uplifted in terms of that equality of opportunity which, under the Constitution of the Republic of India, is their inherent and inalienable right. It is through science and science alone that the full achievement of this goal will be rendered possible. The opportunities for national service which thus await the present generation of Indian scientists cannot be over-emphasised. They can therefore legitimately claim from the State unstinted support for carrying on their progressive activities. This support, whether coming from the State or from private sources, must not in any way curb the independence of their profession or render them subservient to the ideologies of any party or faction. Nothing is more important or sacred both from the point of view of their own work and from that of national advancement that our Universities and Research Institutions should be allowed to grow in an atmosphere of freedom. We are fortunate in having amidst us today Pandit Jawaharlal Nehru not only because he is our Prime Minister but also because of his unflinching faith and interest in the cause of progress of science in India. Let me fervently wish that during the difficult period of transition through which our country is passing, our scientific workers throughout the land may uphold the highest traditions of scientific pursuit and so consolidate and co-ordinate their activities as to be able to contribute their due share in the great task of national reconstruction. I wish every success to your deliberations, under the leadership of your distinguished President, Prof. Mahalanobis.

After the inaugural speech of Dr. Syama Prasad Mookerjee, Pandit Jawaralal Nehru was requested to say something by the President.

Prime Minister, Hon'ble Pandit Jawharlal Nehru, while addressing the Conference paid tributes to the visiting scientists and said:—

Ladies & Gentleman,

"These eminent men and women should not confine themselves to the deliberations of the Conference alone but should talk to our youth and make them feel the international quality of science. Men and Women of Science must inculcate a spirit of international outlook in the minds of India's youth, who would have to bear the burden of future administration of India.

"In the olden days the men of knowledge had had to go to those in power for their maintenance. Their works had to be dedicated to those who dominated that age. But now the scientist stood on the same footing as the politician. The scientists having become fairly important, the politician, whether he knew anything about science or not now praised science all the time.

"Whether we understand science or not we are now certainly very much conscious of the fact that modern world is dominated by science. To-day we want the scientist to help us in our jobs. But we do not like his suggestions and even begin to think he is interfering too much in other people's way of doing things. The politician neither follows the advice given to him by the scientist nor follows his own way. It is obvious that in india and many other countries round, about this is what is happening.

"We have certain primary problems of great importance. Many other countries, whatever may be their social and economic problems are having fairly high standards of living. In these countries, where the necessities of life are provided to a great measure, the primary problems do not assume as great an importance as in our country. The people and the Governments of those countries can think of peace and war, prepare for war and talk of peace as the case may be. In fact, in some places the two things go together.

"In an underdeveloped country like India primary needs were such that they could not talk in any other terms except financial stringency and balancing the economy. Situated as we are, our basic desire is not to get entangled in the tangled web of power politics. Friction caused by power politics will lead to war. Everything we desire and work for in India requires peace and a calm atmosphere to strive for the development of the country so that we may fulfil those primary needs of the people.

"There is no doubt that in India there is a growing realization of this fact that the politician and the scientist should work in close co-operation. The solution of all our social and economic problems depends on this Co-operation and no state can afford to ignore this fact.

"We got power, and it was followed by difficulties and problems of extreme urgency. Whether we have faced these difficulties adequately or not, we were compelled to put aside vague conceptions and proceed with the urgent need of the hour. To-day unexpected pressure has been brought to bear upon us in economic and other spheres with the result that we have to think entirely in terms of rigid economy. All these difficulties came when we had thought of a vast number of schemes to raise standards in India. In many ways we in India are at a very low level. We have to solve our problems and overcome our difficulties. For this we want the assistance of scientists in as practical a way as urgent a way as possible.

"In India, we were dominated by a lawyer's mentality and more lately by a classical philosopher's. Latest, in the picture was the business man's mentality. The lawyer still played a fairly important part in Indian politics. But neither the lawyer nor the classical philosophers can solve our problems. Present problems of India are to be tackled not with the approch of a lawyer or a classical philosopher but with a partly scientific and partly engineering approach. I doubt very much if a business man with his limited outlook can play any part at all. Our problems are to be tackled not with the spirit of a man who does things himself and does not sit in the office ordering people about.

"I appeal to you not to think too much of science metaphysics or hypothetical theories but to become objective realists. I also appeal to young men and women of India to give up their nationalist sentiments now that we are free from colonial rule and are a sovereign nation and channelize your energies into constructive spheres. But if we still continue to show our nationalist sentiment then our country or for that matter any other nation, cannot aspire to a great future or an honoured place in the comity of nations."

9. ANNUAL REPORT OF THE INDIAN SCIENCE CONGRESS ASSOCIATION 1949

INTRODUCTION

During the year under report, the activities of the Indian Science Congress Association have been maintained at a satisfactory level inspite of depletion of staff and shortage of office accomodation. Several Members and office Bearers of the Association were invited by the Government of India to work in a number of Expert Committees to give advice to Government in various developmental schemes and projects. Two important delegations—one to the Natural Resources Conference at New York and another to Australia—were sent by the Government of India and in both these delegations, Members of the Indian Science Congress Association played very prominent parts, bringing Indian Science to the notice of the world. As in previous years, the Association received recognition from many foreign Scientific Bodies. A large number of enquiries were received from Scientific Associations in Australia, America, Canada, Great Britain, Russia, etc. and also from such countries as Ceyion, Afganistan, Indo-China and Israel. Because of lack of funds, the Association could not honour the invitations by sending special delegates but had to remain content by sending messages of good will, so that reciprocity could be adequately maintained. It is hoped that with the betterment of the financial position of the Association, more contacts could be maintained and mutual relationship with the Scientists and Scientific organizations in these countries developed. It is a welcome sign that the work of the Indian Science Congress Association is being increasingly recognised beyond the borders of India.

Thirty-sixth Session: The 36th Session of the Indian Science Congress was held at Allahabad from 2nd to 8th January, 1949 under the auspices of the University of Allahabad and was presided over by Sir K. S. Krishnan. All the 13th Sections of the Congress had their separate sessions and the attendance of Ordinary and Full Session Members was good. The *General Committee* met once during the year under the Chairmanship of Sir K. S. Krishnan and discussed several matters regarding the general policy, administration and the lines on which the future policy of the Association should be directed for the expansion of the activities of the Association. A detailed Report will be found in Part I of the Proceedings of Thirty-Sixth Session which has already been circulated to all Honorary and Ordinary Members.

Obituary: With deep regret we have to report the death of two of our distinguished past General Presidents—Professor Birbal Sahni and Sir Ardeshir Dalal—and one of our prominent members, Prof. Benoy Kumar Sarkar. In the early death of Prof. Sahni, India has lost a Scientist-leader of an outstanding character who had dedicated his life to the cause of science and who had been responsible for raising the status of Indian Science in the eyes of the World. Condolence messages were sent on behalf of the Association to the bereaved families.

EXECUTIVE COMMITTEE

The Executive Committee (consisting of 17 Members) met 7 times since the last Allahabad Session. The 7th meeting which was held on 9th December was an Emergency meeting. The meetings were generally held in the Headquarters office of the Association at calcutta. Of the members of the Executive Committee, Prof. P. C. Mahalanobls, Dr. B. C. Guha, Dr. D. S. Kothari, Prof. B. Narayana, and Dr. Baini Parasad were out of India on tour during different periods of the year.

Additional Member of the Executive Committee: The question of nominating a representative of the Department of Scientific Research in the Managing Bodies of Scientific Societies and Research Institutions was raised by the Government of India and the Indian Science Congress Association was asked to consider the proposal in one of the meetings of the Executive Committee. In view of the fact that Government of India gives a grant to the Indian Science Congress Association and in order to secure better cooperation from the Government, the Executive Committee accepted the request of the Government to include a scientist nominated by the Government of India as an *additional member* of the Executive Committee. This will require a change of the Rules of the Association and it was recommended that the changes required should be put before the Council and the General Committee for their approval.

Shifting of the dates of the Science Congress Session: The question of changing the dates of the Science Congress Session had been before the Executive Committee for the last 3 years and several members suggested that back-dating of the Science Congress Session from 2 to 8 January to the 3rd week of December (16 to 23 December) prior to the starting of the Christmas holidays would be helpful in many ways. Last year the question was taken up at the General Committee Meeting but no decision was arrived at. This year a request has been received from the Institution of Engineers (India) either to back-date the Session of the Congress to the last week of December or to post-date it to the last week of January or the first week of February in order to avoid a clashing of dates between the two meetings and to enable the scientists and engineers, who are arriving in India in connection with the World Power Conference and the International Association for Hydraulic Structures Research to attend the sessions of the Indian Science Congress. The matter was discussed at the meeting of the Executive Committee but no decision could be arrived at. It was the feeling of the Executive Committee that in view of the commitments already made by the Association to the proposed session of the Pan-Indian Ocean Science Congress in India either immediately preceding and after the session of the Science Congress in 1951, it might not be desirable to change the dates of the 1951 session. The Centenary Celebrations of the Geological Society of India is also scheduled to be held towards the end of December or early January. Unless full information is available on all these issues, it was considered too premature to take any decision on this question.

Pan Indian Ocean Science Congress: Prof. A. D. Ross, Chairman of the Australian National Research Council, approached the Indian Science Congress Association and the National Institute of Sciences of India to organise a Pan-Indian Ocean Science Congress along with or immediately after the 1951 Session of the Indian Science Congress, on the lines of the Pan-Pacific Ocean Congress organised by America a few years ago. He suggested that such a congress would be able to discuss many scientific and techonological problems peculiar to this zone of the World and would also further the cause of international science. The Executive Committee approved the idea and approached the Department of Scientific Research for opinion of the Government of India in this matter. Sir S. S. Bhatnagar and other members of the Council of the Association have also supported the idea. Details of organisation have yet to be worked out but it is now definite that the first Session of this proposed Congress will be held in India and the Indian Science Congress Association would be in charge of the arrangements, etc.

Co-operation with sister Organisations in India and abroad: Prof. J. N. Mukherji has been elected to the Governing Body of the Indian Research Fund Association as a representative of the Indian Science Congress Association for a period of 3 years from December 1948. Prof. P. C. Mahalanobis and Dr. B. Mukerji were nominated by the Indian Science Congress Association to the Council of the National Institute of Sciences of India as an additional Vice-President and an additional Member respectively for the year 1950.

The Indian National Commission for Cooperation with the UNESCO was formed during the year and the Ministry of Education requested the Indian Science Congress to nominate *four* representative to the Scientific Sub-commission of that body. The President, Sir K. S. Krishnan, the President-elect, Prof. P. C. Mahalanobls and two General Secretaries, Dr. B. Mukerji and Dr. Sanjiva Rao represented the Association at the inaugural meetings at New Delhi. The Association was also requested by the Ministry of Defence to nominate a delegate to attend the Defence Science Conference which was organised for the first time in India. Dr. B. Mukerji and|or Dr. A. C. Ukil were nominated as delegates to attend the conference. In both these cases, the I. S. C. A. undertook no financial commitments towards travel and other expenses of the delegates.

The British Association for the Advancement of Science extended an invitation to the Indian Science Congress Association to send representatives at their annual meeting held at New-Castle-upon-Tyne from 31st August to 7th September, 1949. The Executive Committee decided that in view of the likely presence of the Indian Scientific Delegation for the Lake Success meeting in London at that time, it would be advisable to request all the members of that delegation who are also members of the Association to attend the British Association Annual Meeting. The following names were communicated to the British Association as Indian Science Congress Association's delegates: Sir S. S. Bhatnagar, Prof. P. C. Mahalanobls, Sir K. S. Krishnan, Sir J. C. Ghosh, Dr. J. N. Mukherjee and Dr. S. L. Hora. The Executive Committee further suggested that Prof. S. Bhagabantham, Scientific Liaison Officer in the High Commissioner for India in London, should also attend the meeting on behalf of the Indian Science Congress Association. In the absence of Prof. Bhagabantham from London, His Execellency the High Commissioner for India in London appointed two members of his staff Dr. V. S. Shemberkar and Dr. B. N. Mukherjee—to be present at the British Association Meeting as observer-delegates on behalf of India. At this meeting, Prof. P. Auger, Head of the Natural Science Department of UNESCO, discussed the desirability of forming a 'World Federation of Associations for the Advancement of Science'. This proposal was forwarded for consideration of the Executive Committee and it was felt that before committing the Association to any definite opinion on the subject, further elucidation of the specific objectives of such a World Federation should be called for.

The Indian Science Congress Association was invited to send a representative to be present on the occasion of the dedication of the Institute of Physics and Physical Chemistry and the laying of the corner-stone of the Institute of Experimental Biology of the Weizmann Institute of Science, Rehovoth, Israel. The Executive Committee decided to send messages of greetings and requested the Department of Scientific Research, Government of India, to send an Indian Scientist to Israel on government expense, if possible.

Messages and telegrams expressing the good-will and felicitation of the Indian Science Congress Association were sent to the Institute of Paleobotany, Lucknow, Roorkee University, Ceylon Association of Science, Society for the Study of Industrial Medicine, and many other institutions.

GENERAL ADMINISTRATION

Drs. B. Mukerji and B. Sanjiva Rao, the General Secretaries, carried on the administration of the Association during the period under review. As an economy measure, the post of Assistant Secretary was not filled on the recommendation of the Executive Committee and this naturally placed a lot of burden on the General Secretary at the headquarters of the Association at Calcutta. However, through the co-operation of the Members of the Executive Committee, the office work was not permitted to suffer and all arrear work has also been completed. A branch office is also functioning at Bangalore under Dr. B. Sanjiva Rao.

Government of India Grant-in-aid:—It will be recalled that for some years past the Association had been trying to impress on the Government of India the need for an annual recurring grant of Rs. 25,000|- for carrying out its scientific activities, for maintaining its office on a high level of efficiency and for the regular publication of its Proceedings. The cost of paper, printing and overhead charges in connection with dearness and other allowances have increased considerably during the last few years and the income of the Association from the membership subscriptions alone is not adequate to meet all these demands. Due to an all-round economy drive by the Government of India, it has not been possible for the Association to receive the grant of Rs. 25,000|- but a grant of Rs. 15,000|- has been received during 1949-50. There is no certainty whether this grant would be forthcoming next year. In order to make the Association self-sufficient in the matter of finances, the Executive Committee recommended an increase in the membership subscription from Rs. 12|- to Rs. 15|-. Though the printing charges and cost of paper, etc. have increased nearly fourfold during recent years, there had not been any increase in membership subscription. This recommendation of the Executive Committee had already been circulated to all Council Members and some replies had been recived approving of the suggestion. In this connection it may be pointed out that the Govt. of India in the Department of Scientific Research are strongly in favour of this suggestion. This recommendation will be considered at the General Committee meeting in Poona in January, 1950 for final ratification.

Association Office: With the increase of the work of the Association it is being felt that the limited accommodation, which the Association has at present in the premises of the Royal Asiatic Society of Bengal, will no longer be adequate for the purpose. The Association, therefore, tried to secure additional accommodation, particularly for the maintenance of its old publications, records, papers, etc. So far no success has been achieved in this direction. The question of buildings a separate house for the accommodation of all scientific Bodies with their head offices in Calcutta, on the lines of the Burlington House in London, has been taken up recently and discussed in several meetings of the Mining, Geological and Metallurgical Institute of India, Calcutta. The Science Congress Association was invited to send representatives to this meeting and Mr. B. K. Sarkar, one of the members of the Executive Committee, represented the Association in this body. The details of payment, etc have not yet been finalised but there seems to be some possibility that the project will materialise, and in that case, the Association has been assured suitable accommodation in that building, both for its office and for its lecture and symposia rooms. There is definite need for a building of this type and the sooner such a project is brought to fruition the better for all scientific with their headquaraters in Calcutta. The funds of the Association are not enough to construct a building of its own.

Membership Drive: As a result of the last world war and various other difficulties, no effort was made for some years to increase the membership of the I.S.C.A., which was showing a tendecy to decline. The Executive Committee therefore felt that a 'membership drive' at this stage would be necessary and at their request, the General Secretary, Dr. B. Mukerji, prepared a small pamphlet giving the objects and scope of the Association and the good work that this Association had been doing in the past. This pamphlet was distributed to all Ordinary, Full Session and other Members and each Member was requested to exert his personal influence to add at least one more 'Ordinary Member' to the list of members of the Association. This drive has shown some response but it not adequate. The American Association for the Advancement of Science has nearly 33,000 members but the I.S.C.A. membership still does not exceed the 2000 figure. It is proposed to maintain this 'menbership drive' next year also, so that more and more younger scientists would be brought within the fold of this Association.

Provident Fund Scheme for employees: For some years past, efforts were made to create a Provident Fund Benefit scheme for the employees of the Asssciation. During this year definite shape was given to this programme and now the employees of the Association are entitled to the benefits of Contributory Provident Fund, as has been approved in many similar non-official Institutions.

Printing of Proceedings: Due to shortage of paper and printing difficulties, the Proceedings could not be issued regularly since 1945. Through a determined effort of the Calcutta Office, this position has now been neutralised and this year all the 4 parts of the Proceedings of the Allahabad Session has already been printed and circulated. It is proposed to stick to this regular schedule in future years.

In pursuance to the recommendation of the Council not to publish Abstracts of papers, which are not accompanied with *full papers,* a circular letter was issued to all members bringing pointedly to their notice the provisions of Rule 34, which demands that Abstracts of papers must be submitted for printing with their *full papers* to the General Secretary before 15th September. As a result of this, the number of Abstracts received this year has been lower than usual, and many Abstracts have been refused publication because they were not accompanied with full papers. From next year it has been suggested that Abstracts should also carefully edited by the Sectional Presidents, so that no Abstracts would exceed the 200-line limit recommended under the Rules of the Association. The Executive Committee have also prepared a set of instructions on 'Editorial Guidance' for papers with the co-operation of Mr. J. Coates, President of the Section of Geology & Geography, 1949-50 and it is proposed to circulate this to all Sectional Presidents for future guidance and compliance.

WORK OF DIFFERENT SUB-COMMITTEES

(*i*) *Sub-Committee to consider the various implications of Dr. D. D. Karve's letter*: At the last Allahabad Session of the Congress, Dr. Karve addressed a letter to the General Secretary, I.S.C.A., bringing out certain specific suggestions for the reorganisation of the I.S.C.A. and also suggested a modification of the present system of election of members to the Executive Committee and Sectional Committees. The Executive for the year 1949 considered this letter in its very first meeting, and appointed a Sub-committee consisting of Prof. P. C. Mahalanobis (Convenor), Dr. S. K. Mitra, Dr. S. L. Hora, Dr. D. D. Karve, Dr. P. K. Ghosh, Dr. B. Mukerji and Dr. B. Sanjiva Rao (General Secretaries) to discuss the various implications of Dr. Karve's letter, *inter alia,* taking into consideration the present Rules and Regulations of the I.S.C.A. Later, Prof. Mahalanobis declined the Convenorship of this Sub-Committee and it was suggested that the meetings should be held on invitations being issued by the General Secretaries. In order to get the opinion of Dr. Karve, Dr. B. Sanjiva Rao, the General Secretary at Bangalore, was requested to contact Dr. Karve and get his opinion on some of the points raised by him. Prof. Sanjiva Rao made a report after consulting Dr. Karve and suggested that the best solution of the problem would be to have the members of the Executive Committee of the I.S.C.A. elected on zonal basis, so that the Association could get a real all-India representation. The matter was considered by the members of the Sub-committee specially constituted for the purpose and was referred back to the Executive Committee. The Executive Committee thought that at this time when inter-provincial amity and good will have to be created on all fronts, it would be a retrogade step to adopt the zonal system of election and felt that the existing practice of free election of members from all over India would be in the best interests for the democratic background of the Association. However, the Committee felt that the question of zonal election should be again gone into in further detail by another Sub-committee consisting of Dr. U. P. Basu (Convenor), Dr B. C. Guha, Prof. J. M. Sen, Dr. S. L. Hora and one of the General Secretaries. As the matter required very careful and detailed consideration, it was felt that rushing through such a decision would not be to the best interest of the Association, and it was decided to consider the matter again next year.

(*ii*) *Sub-Committee on Scientific Development of Andaman and Nicobar Islands*:. On the suggestion of Mr. B. K. Majumdar the Association appointed a Sub-committee to report on the scientific development of the Andaman and Nicobar Island with particular reference to the colonization scheme, which was then prominently in public view. Mr. B. K. Majumdar was appointed Convener of this Sub-committee but as he had to be out of station for some time, Dr. A. K. De was later appointed Convener of this Sub-committee.

(*iii*) *Sub-Committee to devise ways and means for improving the financial position of the Indian Science Congress Association*: In view of the increasing expenditure towards printing etc. of the Association, the Executive Committee appointed a Sub-committee to devise ways and means for improving the financial position of the Association. This Subcommittee was constituted by Dr. K. N. Bagchi, Treasurer (Convener) Mr. B. K. Sarkar, Dr. U. P. Basu, Dr. S. L. Hora and the General Secretaries. This Subcommittee suggested that the appointment of the Assistant Secretary should be withheld for some time and that the number of Abstracts being printed should be substantially reduced. Both these steps were taken during the year under review.

(*iv*) *Sub-committee to draft reports for UNESCO, Paris*: The office of the UNESCO requested the Indian Science Congress Association to prepare and submit reports on the four following subjects: (*a*) Means of extending collaboration between Association for the Advancement of Science, (*b*) The Science Club Movement, (*c*) Popularization of Science through cheap books and clubs and (*d*) The interaction between science and society. A sub-committee consisting of Dr. B. C. Guha (Convenor), Prof. J. M. Sen, and Mr. S. N. Sen (originally of the NUESCO, Paris) was constituted to look into this matter. The Sub-committee decided that the contracts of the UNESCO in this connection should be accepted by the Indian Science Congress Association, and that Mr. S. N. Sen should be requested to prepare the four reports on behalf of this Association. It was also agreed that Mr. Sen should be given an honarorium for this work from the funds that are being placed at the disposal of the Association by the UNESCO for this particular purpose.

(*v*) *Sub-Committee on 'Science and its Social Relations'*: This sub-committee continued to function with Prof. J. M. Sen as its Convenor during the year under review. As usual, a special symposium on 'Application of Science in India for Social Welfare' was held at the Vizianagram Hall, Allahabad University, Allahabad, under the auspices of this Subcommittee and was presided over by Sir K. S. Krishnan. A report of this had already been published in Part IV of the Allahabad Proceedings. This year, a symposium on 'Engineering Developments in India in relation to Social Welfare' has also been organised at Poona and this symposium is likely to attract a number of important speakers.

(*vi*) *Finance Committee*: Mr. H. L. Sen Gupta, and Ordinary Member of the Association was appointed to the Finance Committee for 1949-50. According to Rules, the membership of this Committee is open only to resident members of the Association in Calcutta so that bills, etc. could be checked, etc., from time to time.

VISIT OF FOREIGN SCIENTISTS

It would be recalled that during the last Allahabad Session, several foreign scientists, such as Sir Robert Robinson, Prof. H. Mark, Prof. Szent Gyorgyi, Prof. C. H. Best, J. H. Burn, Prof. and Madame Joliot-Curie and Prof. D. Englehardt, were invited to attend the session, but due to the late receipt of the invitation none were able to honour the request. Only Prof. S. Chapman (Grant Britain) and Mr. Govind Behari Lal (America) attended the Allahabad session. The Executive Committee discussed the position and decided that in view of the commitments alrerdy made and in view of the delay that occurred in the issuance of invitation last year, it is only proper that foreign scientists who were invited last year but who could not make it convenient to come to India, should again be invited this year, as early as possible, with the concurrence of the Department of Scientific Research of the Govt. of India. It was, therefore decided that the following scientists should be invited immediately: Sir Robert Robinson, (Gt. Britain) Prof. and Madame Curie Joliot (France), Prof. Herman Mark (America), Prof. Szent Gyorgyi (originally of Hungary, now residing in the U.S.A.), Prof. C. H. Best (Canada), Prof. J. H. Burn (Great Britain), and Prof. Desmond Bernal (Great Britain). It was further decided that if funds were available, 4 other foreign scientists should also be invited, comprising as many aspects of science as possible. For the selection of these 4 scientists, it was decided to seek the opinion of the members of the Council and the final selection be made with the approval of the Department of Scientific Research. The Government of India in the Department of Scientific Research agreed with the above decision and invitations were immediately sent to the above mentioned scientists through the respective Indian Embassies. Prof. J. H. Burn, Prof. C. H. Best and Prof Szent Gyorgyi expressed their inability to come to India to attend the Poona Session and Department of Scientific Research invited Dr. E. U. Condon (America) and Prof. D. Englehardt (Russia) in the vacancies caused by the non-acceptance of the three scientists mentioned above to come to India. According to the latest information, it is now known that the following scientists are definitely attending the Poona session in 1950: Prof. Sir Robert Robinson, Prof. Desmond Bernal, Prof. and Madame Joliot-Curie, Prof. Herman Mark, Dr. E. U. Condon. The Government of India in the Department of Scientific Research sanctioned an amount of Rs. 57,800|- this year in connection with the expenses of travel, accommodation, stay, etc. of the foreign scientists in India.

Prof. P. C. Mahalanobis, President-elect, suggested in one of the meetings of the Executive Committee that it would be desirable also to invite the overseas scientists who are available in India to attend the Poona session, so that the work of the Association would be known to as many people as possible. In this connection he suggested that the following scientists be invited to attend the Poona: Prof. A. H. Compton (U.S.A.), Prof. P. Auger (Scientific Secretariat, UNESCO, Paris) Prof.

O. E. H. Rydbeck (Sweden), Prof. Herman Wold, (Uppsala University, Sweden), Dr. Walter Zander, (U.K.), Dr. C. P. G. J. Smit (FAO and UN), Dr. M. J. Miller (Canada), Prof. Marshall Stone, Dr. S. Trone, Dr. Harold Fisher, etc. It was agreed that the expenses for their stay at Poona during the session would be met from the funds of the Association, which will be later recouped from the surplus money that would remain under foreign scientists' account. The General Secretary was requested to get in touch with Dr. S. S. Bhatnagar, Secretary to the Govt. of India, Department of Scientific Research, to get this position regularised.

COUNCIL MEETING

The Council meeting, which was held on 14th January 1949 at the Muir College Building, Allahabad, discussed ways and means for improving the work of the Association. This meeting was presided over by Prof. S. N. Bose. The desirablity of increasing the membership subscription from Rs. 12|- to Rs. 15|- was fully discussed from all angles, but this proposal did not find favour with many members of the Council. Many members pointed out that economy should be effected in the day-to-day administration, & publication of the Association rather than burden the members with additional fees, which will restrict the entry of younger scientists into the fold of the Association. The question was therefore deferred for consideration next year. During the year under review, the question was again opened through a circular letter issued to all Council Members and this year many members replied, expressing their willingness to the suggestion. The Government of India in the Department of Scientific Research after carefully considering the financial position of the Association strongly suggested an increase in membership subscription from Rs. 12|- to Rs. 15|-.

The Council also approved of the idea of holding the Pan-Indian Ocean Science Congress along with or immediately after the Science Congress session in 1951.

A proposal was mooted last year for the preparation of a 'Scientific Directory' in 1950 but due to financial stringency, the Executive Committee did not approve of the idea and suggested that the question be deferred for more favourable times. Therefore the matter was not brought before the *Council* for further consideration.

GENERAL COMMITTEE

The Executive Committee would like to receive suggestion *in writing* from the members themselves for improving the work of the Association. The out-going Executive Committee would request the general body of members to help the Association through their personal influence by enlising more 'Ordinary Members', so that active interest of the members could be focussed through the year on the activities of the Association. With this idea in view, the Executive Committee issued a pamphlet to popularise the aims and objects of the Association. It is being noticed during the last few years that many scientists get themselves enlisted as 'Sessional Members' at the last minute, thereby creating a large shifting membership, which does not help to strengthen the Association. Below is given in a tabular form as zonal distribution of 'Ordinary Members' as on 1st November, 1949.

Bengal	37.6 per cent.
Bombay	16.1 „ „
U. P.	11.3 „ „
Delhi	7.4 „ „
Bihar & Orissa	6.9 „ „
Madras	5.4 „ „

Mysore	3·3	„	„
C. P. & Berar	2.3	„	„
C. I. & Rajasthan	2.8	„	„
Hyderabad	1.9	„	„
Assam	1.3	„	„
East Punjab	1.2	„	„
Travancore & Cochin	0.7	„	„
Kashmir, Ceylon, Foreign and Pakistan	1.8	„	„
	100.0		

Obviously there is need for increasing the influence of the Association in southern, western, central and north western zones. The co-operation of all regular members is earnestly sought in increasing the number of Ordinary Members specially in these areas.

BUDGET AND ACCOUNTS

Budget estimates for the year 1948-49 are given in pages *i* to *xiii*. It will be noticed that the expenditure of the Association has increased considerably. This is only natural because of the all round increase in paper price, cost of printing, staff salary, dearness and other allowances, postal charges, building rents, etc. The urgent need for an increase in the membership fee from Re. 12|- o Rs. 15|- is justified when the steady increase in expenditure is taken into account. This year the budget has been balanced as result of the generous grant of Rs. 15,000|- from the Government of India. The Association should not depend on Government grant as a regular measure. In the interest of continuity of work of the Association and with a view to develop it further, the members are requested to give their serious consideration to the proposal for an increase in membership subscription, which is being put forward.

B. Mukerji,
B. Sanjiva Rao,
General Secretaries.

Calcutta, the 24th December, 1949

10. MEETING OF COMMITTEE

GENERAL COMMITTEE

A meeting of the General Committee of the Indian Science Congress Association was held at the Fergusson College Building, Poona, at 2-30 P.M. on Thursday, the 5th January, 1950. The General President, Prof. P. C. Mahalanobis, was in the chair.

The following members were present:—

Mr. A. Abraham, Mr. N. Adhikari, Dr. S. P. Agharkar, Prof. S. V. Chandrasekhar Aiya, Mr. V. V. Apte, Dr. D. V. Bal, Dr. B. Banerjee, Dr. S. Banerjee, Dr. K. Banerji, Dr. C. Barat, Dr. B. C. Basu, Dr. N. M. Basu, Dr. S. Basu, Dr. U. P. Basu, Mr. P. M. Bhargava, Dr. L. J. Bhatt, Dr. N. B. Bhatt, Dr. G. Bhattacharya, Prof. B. V. Bhide, Dr. P. C. Biswas, Dr. A. N. Bose, Dr. A. K. Bose, Dr. S. R. Bose, Prof. S. N. Bose, Mr. S. P. Capoor, Dr. D. K. Chakraborty, Mr. S. K. Chakraborty, Mr. G. L. Chandratreya, Mrs. S. K. Chatterji, Dr. S. K. Chatterjee, Dr. M. L. Chatterjee, Mr. A. C. Chatterjee, Dr. B. K. Chauhan, Mr. K. A. Chowdhury, Dr. G. W. Chiplonkar, Dr. M. W. Chiplonkar, Dr. J. K. Choudhury, Mr. J. Coates, Miss. S. S. Corley, Mr. B. K. Das, Dr. G. C. Das-Gupta, Dr. D. S. Datar, Mr. K. L. De, Dr. P. J. Deoras, Dr. R. D. Desai, Mr. A. De Souza, Dr. K. R. Dixit, Dr. K. K. Dole, Mr. S. K. Ekambaram, Mr. A. K. Ganguly, Mr. C. S. Ghosh, Mr. N. L. Ghosh, Dr. T. N. Ghosh, Dr. R. N. Ghosh, Mr. N. C. Ghosh, Dr. S. L. Hora, Mr. S. G. Iyer, Dr. G. V. Jadav. Mr. V. N. Jai, Dr. S. Jalota, Mr. N. S. Joshi, Mr. B. B. Joshi, Mr. C. B. Joshi, Mr. N. V. Joshi, Dr. D. V. Karmakar, Miss. T. R. Kundaji, Mr. F. S. Khambata, Mr. B. D. Kochhar, Mr. L. S. Krishnan, Mr. A. N. Kappanna, Dr. R. C. Lacy, Mr. K. B. Madhava, Dr. L. D. Mahajan, Prof. P. C. Mahalanobis, Dr. D. R. Malhotra, Mr. G. G. Majumdar, Prof. G. P. Majumdar, Mr. B. N. Mehta, Mr. S. M. Mehta, Dr. R. C. Misra, Dr. R. Misra, Dr. K. Mitra, Dr. B. Mukerji, Mr. J. N. Muthuswami, Dr. P. Nandi, Mr. M. C. Nath, Dr. M. C. Nath, Mr. S. P. Phadke, Mrs. Pramila Phatakm, Mr. S. Pradhan, Mr. S. K. Pramanik, Swami Pranavananda, Dr. P. B. Patnaik, Dr. C. Racine, Dr. M. V. Radhakrishna Rao, Mr. S. A. Rahman, Mr. D. V. Rajalakshman, Mr. M. A. Ramaswami, Mr. J. N. Ray, Dr. S. P. Ray Choudhuri, Mr. M. N. Rudra, Mr. T. S. Sadsivan, Mr. Sanghi Indu, Dr. B. Sanjiva Rao, Prof. P. C. Sarbadhikari, Mr. B. K. Sarkar, Dr. S. N. Sarkar, Dr. N. S. N. Sastry, Prof. J. M. Sen, Mr. J. R. Sen, Dr. M. K. Sen, Mr. P. Sen, Mr. N. C. Sen Gupta, Mr. Sethna Suresh, Mr. J. C. Shah, Mr. N. K. Shah, Dr. N. M. Shah, Dr. R. C. Shah, Mr. N. L. Sharma, Mr. H. N. Srivastava, Mr. R. P. Sinha, Dr. H. Srinivasa Rao, Dr. P. V. Sukhatme, Mr. D. C. Tapadar and others were present.

(1) *Minutes Dated 6th January 1949 Confirmed.* The minutes of the last meeting of the General Committee held on 6th January, 1949 (circulated) were taken up for consideration. There were no objections and the minutes were confirmed.

(2) *Annual Report Audited Accounts for 1948-49 and the Budget Estimates for 1949-50.* The annual report of the Executive Committee, audited statement of Account for the year ended 30th November 1949, and the Budget Estimate for the year 1949-50 already circulated were then considered. Dr. B. Mukerji, General Secretary, placed before the meeting, the Annual report, Audited statement of accounts and the budget estimates. There were some discussions on the budget estimates, in which several members participated but ultimately no specific objection was raised and it was adopted.

(3) *Increase of Membership subscription* from Rs. 12|- to Rs. 15|- was hen taken up for consideration. Many members participated in this item and some of the members were in favours of increasing the membership fees some were against this proposal. Prof. P. C. Mohalanobis, President, after careful consideration, put the matter for voting before the meeting. It was then voted by raising hands. As the majority were not in favour of increasing the membership subscription, the discussion was pospond for the next year.

EXECUTIVE COMMITTEE AND COUNCIL

(4) *Announcement of the names of the Executive Committee members and the Council.* Dr. B. Mukerji General Secretary, reported the following resultes of the elections of members to the Executive Committee and the Council for the year 1950-51.

Executive Committee:—Dr. K. N. Bhal, Lucknow; Prof. S. N. Bose, Calcutta; Dr. P. K. Ghosh, Calcutta; Prof. P. C. Guha, Bangalore; Dr. D. S. Kothari, New Delhi; Dr. B. C. Kundu, Hoogly; Prof. S. K. Mitra, Calcutta; Dr. B. N. Prasad; Patna; Prof. L. Rama Rao, Bangalore; Mr. B. K. Sarkar, Calcutta;

Council:—Mr. K. L. Dey, Calcutta; Mr. A. M. N. Ghosh, Calcutta; Dr. B. C. Basu, Calcutta; Mr. B. K. Majumdar, Calcutta; Prof. M. A. Moghe, Nagpur; Mr. S. N. Roy Chowdhuri, Calcutta; Dr. A. C. Ukil, Calcutta;

(5) *Announcement of the name of the General President for the year 1951.* Prof. P. C. Mahalanobis (General President) announced that the Executive Committee

had recommended the election of Dr. H. J. Bhabha, F.R.S., as the General President for the 1951 Session. The proposal was cofirmed by acclamations.

(6) *Announcement of the names of he Sectional Presidents and Recorders for* 1951 *Session.* · Dr. B. Mukerji, General Secretary, announced the names of Sectional Presidents and Recorders for 1951 as follows:—

Sections.	Presidents.	Recorders.
1. *Mathematics,*	Dr. C. Racine, Madras;	Mr. V. V. Narilikar, Banaras.
2. *Statistics;*	Mr. A. R. Sinha, Calcutta,	Dr. K. R. Nair, Dehra Dun.
3. *Physics;*	Dr. G. S. Venkataswaran, Trivandrum;	Prof. K. R. Dixit, Bombay.
4. *Chemistry;*	Dr. R. C. Shah, Bombay,	Dr. T. R. Seshadri, Delhi.
5. *Geology & Geography;*	Dr. J. B. Auden, Calcutta,	Prof. S. C. Bose, Calcutta.
6. *Botany;*	Dr. B. B. Mundkar, New Delhi,	Dr. I. Banerjee, Calcutta.
7. *Zoology & Entomology;*	Dr. N. C. Chatterjee, Dehra Dun,	Dr. L. S. Ramswami, Mysore.
8. *Anthropology & Archaology;*	Dr. S. S. Sarkar, Calcutta,	Mr. V. D. Krishanaswami, Madras.
9. *Medical & Veterinary Sciences;*	Dr. G. Sankaran, Calcutta,	Dr. A. K. Hazra, Bombay.
10. *Agricultural Sciences;*	Dr. J. K. Basu, Solapur,	Dr. S. P. Roy Choudhuri, New Delhi.
11. *Physiology;*	Prof. S. M. Banerjee, Cuttack,	Prof. D. V. Subba Reddy, Madras.
12. *Psychology & Educational Sciences;*	Mr. S. K. Bose, Calcutta,	Miss. S. B. Gupta, Calcutta.
13. *Engineering & Metallurgy;*	Prof. M. S. Thacker, Bangalore,	Mr. K. L. Dey, Calcutta.

(7) *Venue of the next annual session* (1951)—Prof. P. C. Mahalanobis, President, announced that the invitation to hold the next session of the Congress in 1951 had been received from the University of Calcutta. It was therefore considered desirable to hold the next session at Calcutta and was also confirmed.

(8) *Election of two members to each of 13 Sectional Committee.* The General Committee then proceeded with election of members to each of the 13 Sectional Committees. After the names were proposed and duly seconded, the following elections were made by majority of votes:—

Mathematics:—	(*a*) Mr. G. L. Chandratreya, Poona. (*b*) Dr. S. K. Basu, Calcutta.
Statistics:—	(*a*) Mrs. Chameli Bose, Calcutta. (*b*) Mr. S. K. Banerjee, Bombay.
Physics:—	(*a*) Dr. S. R. Khastagir, Banaras. (*b*) Dr. N. B. Bhatt, Delhi.

Chemistry :—	(*a*) Dr. S. M. Das Gupta, Delhi.
	(*b*) Mr. S. M. Mehta, Bombây.
Geology & *Geography* :—	(*a*) Dr. A. K. Dey, Calcutta.
	(*b*) Dr. R. C. Misra, Lucknow.
Botany :—	(*a*) Dr. P. N. Nandi, Calcutta.
	(*b*) Dr. D. Chatterjee, New Delhi.
Zoology & *Entomology* :—	(*a*) Dr. P. J. Deoras, Bombay.
	(*b*) Dr. S. P. Roy Chowdhury, Calcutta.
Anthropology & *Archaeology* :—	(*a*) Mrs. Freda Mukherjee, Delhi.
	(*b*) Mr. B. B. Varma, Delhi.
Medical & *Veterinary* :—	(*a*) Dr. P. C. Sen Gupta, Calcutta.
	(*b*) Dr. A. N. Bose, Calcutta.
Agriculture :—	(*a*) Dr. P. N. Bhaduri, Calcutta.
	(*b*) Dr. C. C. Shah, Annad.
Physiology :—	(*a*) Miss. Sujata Chaudhuri, New Delhi.
	(*b*) Dr. Sachchidananda Banerjee, Calcutta.
Psychology & *Educational* :—	(*a*) Mrs. Promila T. Pathak, Baroda.
	(*b*) Mr. Samiran Banerjee, Calcutta.
Engineering & *Metallurgy* :—	(*a*) Mr. H. N. Srivastava, New Delhi.
	(*b*) Mr. Chandra Sekhar Ghosh, Bangalore.

(9) The Audited Statement of Receipts and Payments for year ending 30th November, 1949 was adopted.

(10) The Budget Estimates for the year 1st December 1949 to 30th November 1950 were approved.

(11) The Secretary reported that Sir, S. S. Bhatnagar, F.R.S., secretary to the Govt. of India, Dept. of Scientific Research, New Delhi, or his representative will be nominated as an additional member in the Executive Committee. He also reported that the Pan Indian Ocean Science Congress will be held jointly with Indian Science Congress at Calcutta in January 1951.

VOTE OF THANKS

(12) The following vote of thanks were unanimously adopted:—

- (*a*) To His Excellency the Governor of Bombay for consenting to be the Patron of the Association for 1950 session at Poona, proposed by the President.
- (*b*) To Hon'ble Dr. Syama Prosad Mukherjee, Minister-in-Charge of Industries and Supplies, for inagurating the session of the Congress, proposed by Dr. B. Mukerji.
- (*c*) To Hon'ble Prime Minister Pandit Jawharlal Nehru, for his presence at the meeting, proposed by Prof. P. C. Mahalanobis.
- (*d*) To Hon'ble Prime Minister of Bombay, proposed by Prof. P. C. Mahalanobis.
- (*e*) To the Vice-Chancellor and the University of Poona, proposed by Dr. B. Mukerji.
- (*f*) To the Local Reception Committee, proposed by Dr. B. Sanjiva Rao.
- (*g*) To the Local Secretaries, Proposed by Dr. B. Mukerji.
- (*h*) To the Treasurer of the local Reception Committee, proposed by Dr. K. N. Bagchi.
- (*i*) To the Volunteers, proposed by Dr. B. Mukerji.
- (*j*) To the President, proposed by Dr. B. Sanjiva Rao.
- (*k*) To the General Secretaries proposed by Dr. S. L. Hora.
- (*l*) To the Tresurer, proposed by Prof. S. V. Aiya.
- (*m*) To Foreign Scientists who came from abroad for attending the Congress proposed by Dr. B. Mukerji.

COUNCIL MEETING: POONA SESSION

A meeting of the Council of the Indian Science Congress Association was held at the Fergusson College Buildings, Poona at 5 P.M. on Sunday the 1st January, 1950. As the President, Prof. P. C. Mahalanobis. was busy elsewhere, Dr. J. N. Mukherjee presided.

Present: Dr. S. P. Agharkar, Mr. J. Coates, Dr. J. K. Choudhury, Mr. B. K. Sarkar, Dr. W. D. West, Dr. B. C. Basu, Dr. D. Chakraborty, Prof. P. C. Mitter, Prof. S. V. Chandrasekhar Aiya, Dr. D. S. Kothari, Dr. B. C. Guha, Dr. A. K. Dey, Dr. P. Maheswari, Dr. B. V. Bhide, Mr. A. M. N. Ghosh, Dr. B. Mukerji (General Secretary).

PROCEEDINGS

1. The minutes of the meeting held on 4th January, 1949, at the Vizianagram Hall, Muir College Building, Allahabad (already circulated) were confirmed.

2. The recommendation of the Executive Committee regarding the need for increasing the membership subscription and the letter from the Under Secretary to the Govt. of India, Dept., of Scientific Research suggesting an increase in the membership Subscription from Rs. 12|- to Rs. 15|- were then taken up for consideration. The Secretary reported that the matter had already been throughly considered by the Executive Committee and the Council for the last two years. Though the Executive Committee recommended the proposal, the council turned it down. This time the Executive Committee again considered the question and recommended the increase of membership fees, not only because of increase in overhead expenditure but also because the Dept. of Scientific Research after mature consideration and after careful scrutiny of the financial returns of the Association strongly suggested an increase also so that the organisation could stand on its own legs in the near future.

Dr. S. P. Agharkar stated that it was not desirable to increase the membership subscription. He added that every effort should be made to reduce the running cost of the Association *e.g.*, Printing Cost, Appointment of an Assistant Secretary. etc. Dr. J. N. Mukherjee, Chairman pointed out from the Chair that appointment of an Assistant Secretary may be kept in abeyance for and this year, at least till intimation of the Government Grant is received. After examination of the balance sheet, he expressed satisfaction at the measures already taken by the General Secretary at Calcutta to keep expenses down. There appears to be no further room for economy excepting the non-recruitment of an Assistant Secretary for another term.

3. Consideration of the recommendation of the Executive Committee for inclusion of a Scientist nominated by the Government of India as an additional member of the Executive Committee of the Association; Resolved that Dr. S. S. Bhatnagar Secretary, Dept. of Scientific research of the Government of India, or his representative may be accepted as a member of the Executive Committee as an 'Additional' member.

4. Consideration of letter (see below) from P. C. Mahalanobis suggesting for the President-elect to take the charge of the office of the President immediately after the Session: The Council did not think it desirable to change the Rule immediately. The president elect of the next year should also be consulted and if the plan is approved, necessary modifications in the rules could be brought about next year.

5. Proposal for holding the Pan Indian Ocean Science Congress along with or immediately after the next session of the Indian Science Congress. Resolved that Pan Indian Ocean Science Congress might be held jointly with the Indian Science Congress with an extension of the Session for two days more, to accomodate additional subjects

or symposia. The proceedings of the two bodies however could be published separately. With a vote of thanks to the chair the meeting terminated.

Extract of the letter No. C 2654|19 dated 23rd January 1949 from Prof. P. C. Mahalanobis, President-elect addressed to General Secretary of the Indian Science Congress-Association.

"There is one matter about which I have already spoken to you. In accordance with Rule 16, the President assumes charge just at the beginning of the Session, gives his address, and then acts as the President of the Executive Committee while the President-elect for the following year is a member of the Committee. I think a much better procedure will be for the President-elect to take charge of his office immediately after one session is over and to deliver his address and preside over the session at the end of his term of office. In this plan the President will be in office before he actually presides over the session and will be thus responsible for the arrangements for the session over which he presides. This is the practice of the American Association for the Advancement of Science and, I believe, of the British Association. I should, therefore, suggest a change in the Rules to enable the President assuming charge of his office immediately after his election and delivering his address and presiding over the session at the end of his term of office. There is only one difficulty in the transitional stage, namely, the President in whose term the proposed change comes into operation will not be able to act as the President of the Executive Committee. In order to facilitate the proposed change in the Rules, I should be very glad indeed to forgo the privilege of acting as the President of the Executive Committee. To be precise, I shall be glad if the Association will allow me to preside over the 37th session and immediately hand over charge of the office to the President-elect to preside over the 38th session. This will avoid the transitional difficulty. As you are aware, I am much interested in the programme of scientific delegations from abroad. According to present plans, I shall be going to Europe in the third week of April and to the U.S.A. in May and halt there for about a month. I am again due to go to Europe at the end of August or early September. If the Executive Committee so desires, I can try to contact personally as many of the invited scientists as possible with a view to persuading them to accept the invitation."

EXECUTIVE COMMITTEE

Ten meetings of the Executive Committee were held during the year 1949-50. The Annual Report published earlier gives the important items of business transacted excepting those done at the meetings held at Poona. Most of the business done at these meetings have been reported to the General Committee.

SUB-COMMITTEE ON SCIENCE AND ITS SOCIAL RELATIONS

A meeting of the Sub-Committee was held at Poona on Wednesday the 4th January 1950 at 2 P.M.

Members Present

Prof. P. C. Mahalanobis (in the Chair), Prof S. P. Agharkar, Dr. B. C. Guha, Mr. J. Coates, Dr. C. Von, F. Haimendorf, Prof. D. Kanga, Dr. D. R. Malhotra, Prof. Kali Prosad, Dr. B. Mukerji, and Prof. J. M. Sen (Convener).

1. Minutes of the meeting of the Sub-Committee held at Calcutta on the 14th September 1949, which had been previously circulated were confirmed.

2. The Annual Report for 1949, which was circulated to the members present, was then read by the Convener (Prof. J. M. Sen) and adopted.

3. With regard to the symposium on Engineering Developments in India in relation to Social welfare, the Convener stated that there were some conflicting items in the two programmes issued by the General Secretary's office and by the Local Secretary's Office. The two programmes gave two different dates for holding the symposium. Ultimately a reconcilation was effected by holding the symposium on Tuesday the 3rd January 1950, in the afternoon from 3 to 5 P.M. in conjunction with the Section on Metallurgy and Engineering under the presidency of Dr. D. R. Malhotra. The attendance was fairly large and it was felt that the attendance would have been larger if the programmes were not conflicting. The Convener reported that a pamphlet had been published and distributed at the symposium meeting giving the following aspects of the topic:—

(1) Engineering Developments in relation to Social Welfare in India (by Prof. M. S. Thacker, Officiating Director Indian Institute of Science, Bangalore); (2) River Conservation and Control (by Mr. S. C. Majumdar, Consulting Engineer to the Government of West Bengal Irrigation and Waterways Department); (3) The Damodar Valley Project in Relation to National Welfare (by Dr. B. C. Guha, Member, Damodar Valley Corporation); (4) Geological work on Dam Sites and Water-Supply Problems (by Mr. J. B. Auden, Superintending Geologist, Geological Survey of India).

The pamphlet also contained a short account of a declaration containing the Principles of a Charter for Scientists drawn up by the Committee on Science and its Social Relations instituted by the International Council of Scientific Unions at its meeting held at the UNESCO House, Paris, in June 1948. The pamphlet also contained the views of the Sub-Committee on Science and its Social Relations of the Indian Science Congress Association on the two following questions:—

(1) In which measure do the methods of international scientific works contribute to the creation of an international spirit and to the maintenance of peace?

(2) In which ways could scientific organisations and scientists intensify their activities for the maintenance of peace?

The members present noted with satisfaction that a symposium on the above mentioned subject could be organised in connection with the thirty-seventh Annual Meeting of the Indian Science Congress and suggested that the synopsises of the papers received for the symposium should be published in Part IV of the Proceedings of the Indian Science Congress. The Convener further reported that there was a lively discussion on the points brought-out in the papers of Mr. S. C. Majumdar and Dr. B. C. Guha (at the Symposium), in which Mr. Trone (of U.S.A.), Mr. Ghosh (of Bangalore)

Mr. K. B. Roy (of Calcutta), and Dr. Malhotra (President of the Section on Engineering and Metallurgy), participated.

It was further resolved that the views of the Sub-Committee in regard to the two questions raised by the Committee on Science and its Social Relations instituted by the International Council of Scientific Unions be placed before the Executive Committee for transmission to the authorities concerned at Paris.

4. During the year (1949) the Government of India, Department of Scientific Research, acting on the advice of the Advisory Committee for Co-ordinating Scientific Work, had requested Prof. J. M. Sen to prepare a report concerning introduction of a course on Science and its Social Relations in the Universities of India, in consultation with Prof. J. D. Bernal. Advantage was taken by Prof. Sen to consult Prof. Bernal when he came to Poona to attend the opening ceremony of the 37th Session of the Indian Science Congress. The report which Prof. J. M. Sen has drawn up and will soon be submitted by him to the Government of India is now given as Appendix to the Annual Report.

5. The subject for the next year's symposium to be held in January 1951, was decided to be left to the Sub-Committee.

6. The Sub-Committee recommended to the Executive Committee that the following members do constitute the Sub-Committee on Science and its Social Relations for the ensuing twelve months (viz February 1950 to January 1951).

(1) General President of the Indian Science Congress Association;

(2 & 3) General Secretaries (Ex-officio);

(4) Treasurer (Ex-officio);

(5 to 17) Presidents of the 13 sections of the 38th Session of the Indian Science Congress (Ex-officio);

(18) Dr. S. P. Agharkar (Poona);
(19) Dr. K. N. Bagchi (Calcutta);
(20) Prof. H. J. Bhabha (Bombay);
(21) Prof. S. N. Bose (Calcutta);
(22) Mr. Nirmal Kumar Bose (Calcutta);
(23) Dr. J. Coates (Delhi);
(24) Dr. Gilbert J. Fowler (Bangalore);
(25) Dr. B. C. Guha (Damodar Valley);
(26) Dr. C. Von F. Haimendorf (Hyderabad);
(27) Prof. D. D. Kanga (Madras);
(28) Mrs. I. Karve (Poona);
(29) Dr. H. K. Mitra (Jamshedpur);
(30) Dr. C. G. Pandit (Delhi);
(31) Mr. Pitambar Pant (Delhi);
(32) Prof. M. N. Saha (Calcutta);
(33) Dr. A. C. Ukil (Calcutta);
(34) Dr. D. N. Wadia (Delhi);
(35) Prof. J. M. Sen (Calcutta).

It was further resolved that Prof. J. M. Sen be elected Convener of the Sub-Committee. With a vote of thanks to the Chair the meeting terminated.

J. M. Sen
Convener

ANNUAL REPORT OF THE SUB-COMMITTEE ON SCIENCE & ITS SOCIAL RELATION FOR THE YEAR 1949.

The annual meeting of the Sub-Committe was held at Allahabad on Monday the 3rd January 1949 at 9 A.M. and a Symposium on Application of Science in India for Social Welfare was held on the 5th January 1949, at 2 P.M. at the Vizianagram Hall. Sir K. S. Krishnan presided and Sir J. C. Ghosh, Sir S. S. Bhatnagar, Dr. J. N. Mukherjee, Dr. H. K. Mitra, Dr. A. C. Ukil, Dr. B. B. Sarkar and Prof. A. C. Banerji spoke on the various aspects of Application of Science for Social Welfare in India. Dr. D. N. Wadia, Dr. W. D. West and Dr. M. S. Krishnan contributed to the Symposium by sending abstracts of their papers dealing with Natural Resources in India in relation to Social Welfare. Prof. M. N. Saha also contributed a paper on University Organisation in relation to Science and Social Welfare. The synopsises of the papers received for the Symposium have been published in Part IV of the Proceedings of the 36th Session of the Indian Science Congress.

During March to August, 1949, the minutes of the meeting of the Sub-Committee held at Allahabad on the 3rd January, 1949, the Annual Report for 1948 and certain papers regarding the activities of the Sub-Committee were forwarded to the members of the Sub-Committee and they were asked to give their views on the two questions raised by the Committee on Science and its Social Relations instituted by the International Council of Scientific Unions, *viz.,*

(1) In which measure do the methods of international scientific works contribute to the creation of an international spirit and to the maintenance of peace?

(2) In which ways could scientific organisations and scientists intensify their activities for the maintenance of peace?

The opinions of the members were summarized by the Convener and were carefully considered at a meeting of the Sub-Committee held on the 14th September 1949, at the Office of the Indian Science Congress, at 1, Park Street, Calcutta. The views of the Sub-Committee as a whole were then recorded as follows and communicated to the Executive Committee of the Indian Science Congress Association. They were also forwarded to all the members of the Sub-Committee who could not attend the meeting held at Calcutta.

Q. 1. In which measure do the methods of international Scientific works contribute to the creation of an international spirit and to the maintenance of peace?

VIEWS OF THE SUB-COMMITTEE

(i) All genuine scientific work tends to create international spirit and helps in the maintenance of peace. It is only when military strategy on the employment of science to purely military ends requiring extreme secrecy is demanded from science that international amity is endangered. This being the case no new methods of international scientific work can help, save by the removal of these new factors. Restoration of free and unfettered exchange of information should be the aim of all scientists.

(ii) Anyone whose reading of scientific literature leads him to consult the results of work in other countries must realise that the fundamental methods of scientific thought are common ground to all nations. There may be something of a national type in the genius of intuitional perception of a possible line of solution to a problem, but the methods of scientific demonstration and verification of a solution are of necessity the same the whole world over.

(iii) Anyone who realises this fact, even from reading (in original or in translation) the work of scientists in other countries is brought to a fuller appreciation of what he has in common with men of other nations, and this must certainly contribute towards conflict which arises primarily from fear of the unknown. When a scientific worker has occasion not merely to read the work of a foreign scientist, but so to exchange views with him as a colleague, there is a greatly increased probability of his appreciating the extent to which co-operation between individuals may be quite irrespective of nationality, and this attitude—which enters at the emotional level—cannot but help to contribute towards the maintenance of peace.

(iv) The general probability is that such benefits will be most fully forthcoming in the sphere of fundamental or abstract scientific work, where the issue will not be clouded by secondary considerations of how the application of the knowledge might put one or the other nation at a relative advantage. There are, nevertheless, many fields of applied science where disadvantages do not come into the question—notably such sciences as tend to raise general standard to be fruitful in promoting a fellow-feeling and a realisation of the benefits to be derived from the maximum development of international co-operation.

(v) If international laboratories are established in different parts of the world, it will go a long way in establishing closer relationship between workers of different nationalities and thereby creating an international spirit which will help in the maintenance of peace.

(vi) Meeting of international bodies should be held in rotation in different parts of the world thereby affording opportunities of closer contact between workers of different nationalities.

Q. 2. In which ways could scientific organisations and scientists intensify their activities for the maintenance of peace?

VIEWS OF THE SUB-COMMITTEE

(i) Scientific organisations and individual scientists have hardly any voice in the political and military set-up of nations. The scientists are merely used as tools for furthering ends of politicians and military strategists.

(ii) There would seem to be three main lines along which science could hope to work positively towards the maintenance of peace, viz.,

(*a*) To demonstrate the benefits obtainable from a general continuance of peace; or, complementary to this, to demonstrate the overall loss that inevitably results from war.

(*b*) To encourage the spread of scientific methods of thought in matters—particularly political matters—in which frequently emotion rather than reason plays a major part; so that policies may be founded upon facts and scientific principles as far as these can be ascertained, with emotion entering as the necessary inspiration towards effort rather than as a controlling urge blind to unpalateable facts.

(*c*) To find out the fundamental causes which lead nations to come to war as a solution of their problems, rather than solving them by other means; and to find whether there is any means of influencing these factors in a direction more favourable for peace. This is a matter on which psychology should eventually be able to give some guidance.

(iii) One of the causes of war appears to be a struggle for control of raw materials available in different parts of this world. Scientific organisations and scientists by their methods of investigations can find substitutes for raw materials which are now available only in a particular foreign country or can create good products from low grade materials which are available in the country, and thereby remove one of the causes of war.

(iv) There should be central organisations like the Rome Institute of Agriculture where literature of different countries on different subjects is summarized, and useful notes are prepared for circulation to different parts of the world. The staff of such a Central Institute should have representatives of different countries. The Central Institute should offer scholarships for studies in different subjects in different institutes of the world to students of all nationalities.

During the year 1949, the question on "Food and World Population" was further discussed by various scientific organisations all over India. This question was at first raised on a scientific level by the Sub-Committee on Science and its Social Relations by organising a Symposium under the leadership of Dr. B. C. Guha at Patna in January 1948. Dr. Gilbert Fowler of Bangalore made a special reference to this question in an article on "Saving the Land" while reviewing two books, viz. 'Our Plundered Planet' by F. Osborn and 'Road to Survival' by William Vogt in the daily paper, the Hindu (Madras) dated the June 26, 1949, and concluded by saying: 'If with all the resources of modern science we find ourselves unable to avert world famine we shall all be to blame'.

At the meeting of the Sub-Committee on Science and its Social Relations, held on the 14th September, 1949, it was decided to hold a Symposium on "Engineering Developments in India in relation to Social Welfare" in connection with the 37th Annual Meeting of the Indian Science Congress to be held at Poona in January 1950. The Sub-Committee of the Indian Science Congress approved of the proposal and later on fixed the 3rd of January 1950, as the date for holding the Symposium. Prof. M. S. Thacker, Mr. S. C. Majumdar, Dr. B. C. Guha and Mr. J. B. Auden have agreed to speak on the various aspects of the subject.

We were grieved to learn that Prof. Benoy Kumar Sarkar of the University of Calcutta, who had been an active member of the Sub-Committee for several years, passed away suddenly in U.S.A. in November 1949. His place on the Sub-Committee has remained unfilled. The vacancy may be filled up at the Annual Meeting of the Sub-Committee to be held at Poona on the 3rd January 1950.

All expenses in connection with the meetings of the Sub-Committee are met by the general office of the Indian Science Congress Association. Hence no separate account of such expenses has been maintained. They are included in the general accounts of the Indian Science Congress Association.

J. M. Sen
Convener.

A REPORT CONCERNING INTRODUCTION OF A COURSE ON SCIENCE AND ITS SOCIAL RELATIONS IN THE UNIVERSITIES OF INDIA.

BY

J. M. SEN.

SECTION I—WHY A COURSE ON THE SUBJECT IS NECESSARY

In his Rushton Lectures on "Education and World Tragedy" Dean Howard Jones has tried to show how far the present system of education has created the terrible problems of our time, viz. war, technology in preparation for war and nationalism, in almost all countries of world. He says that retaining the moral idealism of western civilization as a standard of measurement, if any human being tries to discover what has happened to mankind in the last fifty years such a person would be overwhelmed by a single tragic conviction; namely that the history of mankind for the last half century has been a history of deepening horror. The first half of the twentieth century is nearly over. And what do we find? Since 1899, the earth has scarely known a year without warfare, armed revolt, massacre, pogrom or other ingenious form of slaughter. These fifty years include two infernal conflicts—World War I and World War II. They include such disastrous struggles as the Boer War of 1899-1902, the Russo-Japanese War of 1904-05, the two Balkan Wars of 1912-13, the innumerable wars, revolts, 'interventions' and massacres in Finland, the Caucasus, the Ukraine, Poland, Hungary, Manchuria, Siberia, and other border areas, which followed the Bolshevik Revolution of 1917. They include the long drawn out agony of China, which beginning with the massacre of garrison troops in 1917, continues even to this hour. They include the intermittent civil war in Spain. These are the major events.

But there are the other episodes, tragic in their time, viz. the Cretan massacre during the last two years of the nineteenth century (1899-1900), when the Christians slaughtered the Moslem peasantry; the Boxer rebellion of 1900; the Phillipine insurrection and the 'water-cure'; the massacre of a million Armenians between 1899 and 1919. The year 1922 saw the Irish Civil War in full swing, and there were Black and Tan outrages. The year opened with the slaughter of Greek civilians in Samsun—more than one hundred thousand Greeks had been killed and the climax of 1922 was reached at the taking of Smyrna, when an estimated 200,000 Christians were rendered homeless and the city was given over to pillage, rapine, massacre and fire. There was an earlier Graeco-Turkish war in 1897-98, and an Italo-Turkish war in 1911.[3] Between 1928 and 1935, Bolivia and Paraguay fought to exhaustion over the possession of a tropical jungle. Indeed, during most of these fifty years there have been rebellions in Latin America.

The half century has seen armed rebellion sweep through such famous capitals as Paris, Berlin, Madrid, Athens and Rome. It has seen more or less protracted revolutionary struggles in Russia, Mexico, Spain, France, Germany, Hungary, Austria, Greece, Egypt, Iran, Palestine and other Arabian States, Mongolia, China, and various other countries, besides what uncounted minor uprisings—in Nicaragua, Haiti, Albania, Thailand and the like—only the World Almanac tells us. India has experienced a full blast of atrocities in Calcutta and Noakhali in 1946, throughout the Punjab in 1947, and in Kashmir in 1948. Ours is a sick age.

How many human beings have been killed directly or indirectly in the course of this terrible history? It is almost impossible to find out. For example, we do not know and probably shall never know how many hundreds of thousands have died of violence in Asia and Africa during the fifty years. How many perished during the obscure struggle for the control of Tannu-Tuwa, a country as big as Great Britain, lying between Mongolia and Siberia? How many Koreans were slaughtered by their

Japanese overlords? How many natives of Congo died during the struggle for the control of the Belgian Congo? We do not know how many hundreds of thousands died in Russia, or in neighbouring states during the terrible convulsions that swept over the future Soviet Union between 1914 and the adoption of the constitution of 1925. We do not know how many millions Hitler and his agents killed. But what we know with rough accuracy is sufficiently appalling.

Before 1900, about 25 percent of all battle casualties died; in World War I this increased to 33 1|3 percent. Out of every thousand Europeans alive in the twelfth century it is thought that two died as battle casualties; in the first twenty-five years of the twentieth century 54 out of every thousand so died. Professor Pitirim Sorokin estimates that during the first third of the twentieth century Europe alone suffered 24 million war casualties. From the eleventh century to the end of the nineteenth century war casualties totalled about 18 million. Therefore in the first three decades of the present century 33 1|3 percent more human beings were killed in war in Europe than were killed in the previous 800 years. These figures do not include four other continents and they take us only to the rise of Hitler. Influenza, typhus, starvation, and other destroying agencies killed millions more. It has been estimated that 40 million of world population died, directly or indirectly, in World War I. We do not yet know the figures for World War II. The Japanese dead alone are reckoned at more than three million. The science reporter of the New York Times was thought in 1945, to have written a singularly effective masterpiece about the rare beauty of the atomic bomb upheaval over Hiroshima. This killed or mutilated 150,000 human beings, 30,000 so completely that no trace of them remains. A United Press dispatch from the Vatican in November 1945, estimated the dead, military and civilian, in World War II at over 22 million, and the wounded at 34 million, *i.e.* 56 million casualties in all.

While this blind struggle continues it increases its ferocity. Through the mouth of Satan in *The Mysterious Stranger,* Mark Twain sardonically remarks, "No brute ever does a cruel thing—that is the monopoly of those with the Moral Sense." Millions (nearly 100 million) who died, directly or indirectly in the two World Wars are at peace. Unnumbered thousands of human beings whose lives have been wrecked by war or starvation or despair or disease still exist. Regarding the long range results of war upon our lives Professor Quincy Wright tells us:—"Closely related to the racial (*i.e.* human) cost of war but less susceptible to objective measurement are the social and cultural costs of war in the deterioration of standards. Wars of large magnitude have been followed by anti-intellectual movements in art, literature and philosophy; by waves of crime, sexual license, suicide, venereal disease, delinquent youth; by class, racial and religious intolerance; by persecution, refugees, social and political revolution; by abandonment of orderly processes for settling disputes and changing law; and by a decline in respect for international law and treatises." The standards of only a few, he says, are elevated by war, a minor gain which by contrast deepens the gloom of the general picture. The coarsening effects upon our finer sensibilities of an uninterrupted series of wars, revolutions and bloodsheds have been such that people merely read them as ordinary news in the newspapers and then turn to the sports pages. So deep have we descended into the pit of insensibility that Dr. Irving Langmuir, Nobel Prize winner, physical chemist and associate Director of the General Electric Research Laboratories, solemnly warned a joint meeting of the American Philosophical Society and the National Academy of Sciences in the autumn of 1945 in Philadelphia that "so-called atomic warfare, unless the release of nuclear energy is controlled by the world, may make the entire earth uninhabitable wiping out the ignoble race of men." Dr. Langmuir is a conservative scientist. He spoke sadly and seriously. But the Americans do not believe things like this because they, and possibly people all over the world, do not wish to believe them.

Dr. Langmuir's statement suggests a second basic fact in this brutal history. It is that *modern warfare is increasingly a function of education,* and education is increasingly dominated by war. We do not like to think that this is so. We try desperately to deceive ourselves. One form of optimistic rationalization is the "progress" fallacy. The progress fallacy assumes that mankind always survives any conceivable weapon. Another fact to be observed in this strange, eventful history is to note how nationalism increasingly invades education. The eighteenth century was perhaps the last period when a truly international culture was the common object of study, at least among the cultivated classes in the western world. Till then education was not customarily created or paid for by the state. Throughout the nineteenth century, and increasingly in the twentieth, the doctrine that education is a proper charge against the public purse has meant that the state, in greater and greater degree, has made education the instrument of its own support. The nationalism which this type of education has created has in its turn created an age in which instruments of communication have prematurely thrown cultures into collision with each other before the people were ready to understand one another. This nationalism, which has rallied religion, culture, technology and science itself to its support, now includes education—and it is a necessary part of something called 'national defense.' War, technology in preparation for war, and nationlism—these are three great forces warping the healthy development of education in what we call the civilized world. The problems they raise are deeper and darker than those polite fictions discussed in most educational meetings.

Face to face with the spectre of war, with technology controlled by war, and with an intense and irrational nationalism which, as in the case of atom bomb, dreams of going to war before some other nation shall invent an even more terrible weapon—and this, in a world in which the nations have solemnly pledged themselves to unite for peace—what have the scientists to offer for the guiding of mankind? Our problem is then deeper, more radical, and alas more nearly insoluble than a simple balancing of general gains in health, longevity, good will and control of nature against the stupendous losses of war.

Lord Bertrand Russel, the great English philosopher, in discussing the possibilities of the second half of the twentieth century, which he warns, may bring appalling disasters, says that "dislike of the Soviet system while it justifies us in resisting its forcible extension, does not justify us in going to war to change it where it exists. Our policy must not be that of crusaders, but of nations engaged in collective self-defence. And not merely self-defence, but defence of a way of life that we value. War, even if it were quickly successful, would damage this way of life; we should, when it was over, be less civilized, less humane, less capable of democracy, and less able to carry on the work of art and literature. War for civilization may sometimes be necessary, but civilization is not as good after a serious war as it was before. As guardians of certain things that we value, it is, therefore as much our duty to preserve peace if we can as it is to fight if we must."

SECTION II—SOCIAL PROBLEMS OF MODERN CIVILIZATION

Professor Elton Mayo in his book, *The Social Problems of an Industrial Civilization*, writes:—Technical skill manifests itself as a capacity to manipulate things in the service of human purposes. Social skill shows itself as a capacity to receive communications from others and to respond to the attitudes and ideas of others in such fashion as to promote congenial participation in a common task. In these days, education has gone over—often extravagantly—to the development of technical skills and the appropriate scientific bases for such skills. This would be excellent were it not for the fact that the universities have failed to develop an equivalent study of and instruction in social skill. We have in fact passed beyond that stage of human organization in which effective communication and collaboration were secured by established routines of relationship,

AGAIN:

We have undertaken to transform an economy of scarcity into an economy of abundance, and the technicians are showing us the way. We are committed to the development of a high human adaptability that has not charaterized any known human society in the past, and it is our present failure in this respect that finds reflection in the social chaos which is destroying civilised society.

AND AGAIN:

Under the influence of economic theory, we have a system of education that trains youngmen in technical understanding and technical skill: we do nothing whatever to develop social insight or to impart social skill. Indeed we provide an education that operates to hinder the development of such skills. And the general public, business leaders, and politicians are left with the implication that mankind is an unorganized rabble upon which order must be imposed. It was this delusion that encouraged Hitler's dreams of grandeur.

FINALLY:

We have failed to train students in the study of social situation; we have thought that first-class technical training was sufficient in a modern and mechanical age. As a consequent we may be sometimes technically competent, but we combine this with utter social incompetence. This defect of education and administration has of recent years become a menace to the whole future of civilization.

Professor Northrop also emphasizes the above opinion of Professor Mayo in his book, *The Meeting of East and West,* and says that the present civilization must re-educate itself or perish. The creation in the United Nations pattern of UNESCO—the United Nations Educational Scientific and Cultural Organisation—is a crowning example of world-wide interest in the inter-relations between war, technological training for war and nationalism on the one hand, and education on the other. Education is, then a world-wide problem. The catastrophes of the last half century have affected some parts of educational system in different parts of the world. Nevertheless, it is roughly true that primary education in most countries particularly in India has not been violently altered. Our sociological theories, our political economy, and our doctrines of education are derived from an unbroken tradition of the country. The whole of this tradition is wrapped by the vicious assumption that each generation will substantially live amid the conditions governing the lives of the fathers and will transmit those conditions to mould with equal force the lives of its children. For the first time we are beginning to realize that we are living in a period of human history for which this assumption is false. To express doubt concerning the timeless validity of tradition may shock the academic mind in India but it is nevertheless true that unless a re-orientation takes place in the traditional ideas of education there will be a disaster in the second half of the twentieth century both in social and political life of the country. The troubles lie, not with the tradition, but with human beings who will not live in the glory and wisdom of the tradition. Therefore the tradition must be re-taught. An attempt towards this direction is now being made by the Government of India, Ministry of Education, by inviting the attention of the public to a pamphlet on Basic and Social Education which seeks to provide a short account of what has been and is proposed to be done in the immediate future (vide Pamphlet No. 58 of the Bureau of Education published in 1949).

The discovery of murderous potentialities in nuclear energy and the invention of many death-dealing machines require that education in India must somehow take account of events in a world in which the U.S.A. and Soviet Russia have become dominant powers. The whole of Asia is violently disturbed and man's uneasiness about his traditional values has spread from a few troubled spirits at the top of the social pyramid down among the mass of mankind everywhere. Merely to reaffirm past values by a return upon dead sages will not quite do. What we need is an educational programme that will face the present with courage and interest. One difficulty with educational programmes is that they are never built for time but are always built for eternity. Each pedagogical reformer, convinced that he has found at last a changeless and enduring way of educating human nature, announces his programme as a series of timeless absolutes. Every curriculum has an air of being built upon the impregnable rock of holy scripture; and, since academic institutions are highly conservative, the new curriculum, once alive and vital, when it becomes moribund, either changes slowly or changes not at all.

SECTION III—THE EDUCATIONAL PROGRAMME

It is not necessary to launch another educational reform. What is needed is a reorientation of scientific studies in colleges. The suggestions are not absolute and for all time. The colleges in India ought now to introduce a fairly comprehensive course in *Social Function of Science.*

This course should include—

(*a*) A study of the theory of science and of the application of scientific discoveries to technology.

(*b*) A study of the assumptions and workings of representative governments.

(*c*) A study of the personal relationships in modern society.

Regarding item (*a*), it may be said that professional, vocational, technical or technological training is unavoidable in a fiercely competitive democracy. The problem is not to deny its necessity but to control and guide its force. The problem is to bring our social engineering up to the maturity of our technological engineering. A course in 'General Science', a course in the history of science, a course in the postulates of the scientific method will merely increase our technological confusion unless it is joined to something else. That something else is the study of what happens to scientific discoveries when they are practically put to work in our industrial culture. Economist and sociologist, psychologist and anthropologist must join the scientist and point out that when science invents the internal combustion engine, vast economic and sociological forces are set to work. It is insufficient to praise research for its own sake. The tremendous (and sometimes tragic) results of research for its own sake, when these results take the form of widespread technological change in modern society, are as basic to an understanding of the modern world as any part of scientific theory. The creation of instructional units of this sort will be a matter of great difficulty, but to keep scientific theory in one compartment and economic and social studies of a technological culture in another compartment is precisely the tragic error of our education and of our culture.

Regarding item (*b*)—a study of the assumptions and working of representative governments—it can be said that if the world during the next few years is going to be split, as it threatens to be, between the communistic and the democratic theories of the state, surely our common studies should be far more realistically focussed upon the workings of the principal democratic states of the world. The same logic makes the study of Soviet Russia—its culture, its government, its economic structure, the character and the desires of its myriad peoples—of paramount importance. If Soviet Russia is to become the chief enemy of the democracies we ought to comprehend her; if she is to become the friend and aider of the democracies, all the more reason for widest spread of sympathetic information about the Soviet Russian Empire. In the next quarter of a century this empire is going to be of far greater importance to modern man than the empires of the Caesars or of Charlemagne or of Napolean, now commonly studied in the schools and colleges. Of course it would take a certain amount of courage on the part of the scientific departments and educational authorities in India to advocate a sympathetic approach to the Soviet Russian problem.

Regarding item (*c*)—a study of personal relationships in modern society—it may be said that this is not a subject whose elements can be so specific as the elements of general education previously suggested. Still the need of restoring confidence in the relations between man and man is supreme. Perhaps, in a fiercely competitive society, confidence in these relations cannot be wholly restored but the present corruption of these relations can certainly be checked and the conditions improved. To repeat Professor Mayo's words: "We have passed beyond that stage of human organization in which effective communication and collaboration were secured by established routines of relationship." Professor Mayo rightly charges the present governments with "utter social incompetence." *But the beginning of social competence is the trust of man in man;* and a wider understanding of the psychology of personal relationships seems to scientists a more desperate need in our education than polite courses in literature, philosophy and the fine arts.

SECTION IV—CHARTER FOR SCIENTISTS

A combination of all three aspects mentioned above will necssarily create a demand for laying down certain principles of a Charter for Scientists. And this was exactly what the Committee on Science and its Social Relations instituted by the International Council of Scientific Unions at its meeting held at the UNESCO House, Paris, did on the 15th and 16th June 1948. The principles of a Charter for Scientists which the Committee has drawn up can be summarised in the following sentences:—

The prominent position held at present by science in society, and the rapid transformation of the world through the application of science, carry with them for scientific workers special obligations over and above the ordinary duties of citizenship. Besides this the scientific worker has special responsibilities since he or she has the possibility of obtaining information not readily available to the average citizen. It thus becomes the duty of the scientist to:

(*a*) maintain a spirit of frankness, honesty, integrity and co-operation, and to work for international understanding;
(*b*) consciously examine the measuring and purposes of the work that he or she is performing;
(*c*) when in the service of others enquire into the purpose for which the work is being done and the moral issues that may be involved;
(*d*) promote the development of science in the way most beneficial to mankind and exert his or her influence as far as possible to prevent its misuse;
(*e*) assist in the education of the people and the Government in the purposes and achievements of science.

In order to fulfil these obligations it is necessary to claim certain rights for scientists, the principal ones of which are:

(*i*) freedom of publications and the utmost freedom to discuss one's work with other scientists;
(*ii*) economic security and the right to participate freely in all activities permitted to all citizens; and
(*iii*) the possibility of obtaining information about the purposes for which his or her work is being done.

The committee on Science and its Social Relations instituted by the International Council of Scientific Unions has also raised the question of giving attention to *man* himself as the fundamental unit of society and therefore has asked everybody to consider three principal aspects of social relations of science, viz:—

(*i*) the scientist before society;
(*ii*) changes introduced in human societies through the technological development of science;
(*iii*) the antagonism between biological order and social order.

In the world generally the fall of the Fascist States has left a kind vacuum in beliefs, which must be filled; and if the democratic state has not the dynamic energy to draw to itself the affirmative allegiance of the younger generation in India then the democratic state will not have a healthy growth. The case is not simple 'patriotism'. The task of education is, along with other institutions of the state, to furnish this dynamic. But it must be an intelligent dynamic. Hence it must deal with the individuals as units of the society. Dr. Rajendra Prasad, President of the Indian Constituent Assembly, recently stated at Wardha that "we must cencentrate on the individual, on whom depends the solution of many problems confronting the work; it is individuals who constitute a nation. We have to reform the individual, make him really an instrument of peace so that he may influence other individuals around him. He may influence his Government. Matatma Gandhi tried to mould the individual throughout his activities in Africa and in India; it was individuals whom he moulded and he hoped that in that way he would be able to create a society of men in the light of his teachings. We have to take decisions which will help individuals, and which will help us all individually to create that kind of society which will banish war".

Professor Bernal just before the World War II emphasized the same aspect from the stand point of a scientist. He stated—"we have in the practice of science the prototype for all human common action. The task which the scientists have undertaken—the understanding and control of nature and of *man himself*—is merely the conscious expression of the task of human society. The methods by which this task is attempted, however inperfectly they are realized, are the methods by which humanity is most likely to secure its own future. *In its endeavour science is communism.* In science men have learned consciously to subordinate themselves to a common purpose without losing the individuality of their achievements. Each one knows that his work depends on that of his predecessors and colleagues, and that it can only reach its fruition through the work of his successors. In science men collaborate not because they are forced to by superior authority or because they blindly follow some chosen leader, but because they realize that only in this willing collaboration can each man find his goal. Not orders, but advice, determines action. Each man knows that only by advice, honestly and disinterestedly given, can his work succeed, because such advice expresses as near as may be the inexorable logic of the material world, viz stubborn facts. Facts cannot be forced to our desires, and freedom comes by admitting this necessity and not by pretending to ignore it. These are things that have been learned painfully and incompletely in the pursuit of science. Only in the wider tasks of humanity will their full use be found."

The desirability of introducing the subject of "Science and its Social Relations" in the universities of India has been recognised by the Advisory Committee for Co-ordinating Scientific work of the Government of India, of which the Prime Minister Pandit Jawharlal Nehru is the Chairman. The Prime Minister is most anxious that the students in the Universities and technological colleages in India should know how through the instrumentality of science the political and social conditions of India are rapidly changing. The application of natural sciences for social welfare, the utilization of natural resources for social welfare, the application of biological sciences for social welfare, the engineering developments for social welfare, the social problems of an industrial civilization, are merely some of the vast number of topics which require careful attention of the faculties of science, technology, commerce and education of the universities in India.

SECTION V—THE SYLLABUS OF STUDIES

Professor J. D. Bernal in his well known book "The Social Function of Science" has made a critical examination of the function of science in society. He narrates what science does and mentions what science could do. In the preface to his book, he says:—"It used to be believed that the results of scientific investigation would lead to continue progressive improvements in conditions of life; but the war and then economic crises have shown that science can be used as easily for destructive and wasteful purposes, and voices have been raised demanding the cessation of scientific research as the only means of preserving a tolerable civilization. Scientists themselves, faced with these criticisms, have been forced to consider effectively for the first time how the work they are doing is connected with the social and economic development which are occurring around them......To begin with, it is necessary to consider the social function of science not absolutely, but as something which has grown up imperceptibly with the growth of science. Science has ceased to be the occupation of curious gentlemen or of ingenious minds supported by wealthy patrons, and has become an industry supported by large industrial monopolies and by the State. Imperceptibly this has altered the character of science from an individual to a collective basis, and has enhanced the importance of apparatus and administration. But as these developments have proceeded in an uncordinated and haphazard manner, the result at the present day is a structure of appalling inefficiency both as to its internal organisation and as to the means of application on problems of production or of welfare......The application of science furnishes other problems. Here the tendency in the past has been almost exclusively that of directing science towards improvements in material production primarily through lowering the cost and towards the development of the instruments of war. This has lead to an almost complete neglect of those applications which would be of more immediate value to human welfare, in particular to health and domestic life. The result has been an extraordinary disproportion in the development of different sciences, the biological and still more the sociological sciences having been starved at the expense of the more immediately profitable physical and chemical sciences......Any discussion of the application of science necessarily involved questions of economics, and we are driven to enquire how far the various economic systems now existing or proposed can give the opportunity for the maximum application of science for human welfare. Further economics cannot be separated from politics...... The universal preparations for a more general and terrible war have affected scientists not only as citizens, but also through their work. Science itself seems in danger. The scientist has begun to realize his social responsibility but if science is to fulfil the function which its tradition demands, and to avoid the dangers which threaten it, we require an increased appreciation, both on the part of scientists and of the general public, of the intricate relations between science and contemporary life."

It is therefore suggested that the following topics from Professor Bernal's book might be prescribed as a Syllabus for the course on science and its social relations in the universities in India:—

PART I.

(1) The interaction of science and society.
(2) Science, Learning and Craft.
(3) The Birth of Modern Science.
(4) Science and Manufacture.
(5) Science and Imperial Expansion.
(6) Science and Socialism.
(7) Science Teaching in the Past
(8) Science in Schools.
(9) Science in the Universities.

(10) The Training of Research Worker.
(11) Popular Science.
(12) Three aims for science—psychological, rational and social.
(13) The Ideal of Pure Science: Science as escape; Science and cynicism.
(14) The Technical Inefficiency of Science; Bad Organisation; Laboratory waste of skill; false economies; salaries of Scientific Workers.
(15) Research in Industry: Secrecy; lack of freedom; Low Standard.
(16) Lack of Co-ordination of Research.
(17) The effect of inefficient organisation.
(18) The Interaction of Science and Technology.
(19) The Profitability of Science.
(20) Industrial Competition and Research.
(21) Monopoly and Research.
(22) The Stifling of Research: Patents.
(23) Co-operative Industrial Research.
(24) Economic Nationalism and Research.
(25) The Distortion of Industrial Research.
(26) Science and Human Welfare.
(27) Science and War.
(28) War Research Today.
(29) Science and Armaments.
(30) National Food Supplies.
(31) The diversion of Research to War Uses.
(32) The Scientist faces the Problem of War.
(33) International Science today.
(34) The Problem of Language.
(35) The Scientific World and its Divisions.
(36) Science in the Older Industrial Countries.
(37) Science in the United States.
(38) Science in the East.
(39) Science and Fascism.
(40) Science and Socialism.

PART II.

(1) The Reorganisation of Science.
(2) Changing the teaching of science in schools and in universities.
(3) Revising the curriculum.
(4) Reorganisation of Research.
(5) Scientific Communication:—the function of scientific publications; the international problem: popular science.
(6) The Finance of Science.
(7) The Strategy of Scientific Advance: Can science be planned? A Survey of Science; the prospects of Science; Physics, Chemistry, Biology; Social Science and Psychology: The Future of Science.
(8) Science in the Service of Man. Human Needs—psychological and social—Food; Clothing; Housing; Health; Work; Play and Recreation; Production; Mining; Power Production; Engineering; Chemical Industry; Transport; Distribution; Communication: Administration and Control; General Effects of Science; Science and Society.
(9) Science and Social Transformation. Social Conditions and Science. How Science changes Society? The Scientific Worker of Today. The Scientist as Citizen. Social Consciousness. Organisation of Scientists. Science and Politics.

(10) The Social Function of Science. The Major Transformation of History; Society and Civilization; The Scientific Revolution; The Role of Capitalism; The Social implications of Science; The Tasks of Science in the transition period; Preventible evils; Discovery and satisfaction of needs. Science and Culture.

In the proposed syllabus outlined above, there is no mention of the organization of research in Britain. Professor Bernal in his book has devoted a full chapter on the Existing Organisation of Scientific Research in Britain. What however should be included in the syllabus must have reference to the following topics, viz—

Part III.

(1) University, Government and Industrial Projects and Research in India and National Laboratories.
(2) Scientific Societies in India and Scientific Publications in India.
(3) Research in the Universities of India.
(4) Governmental Scientific Research in India.
(5) Medical Research in India.
(6) Public Health Research in India.
(7) Agricultural Research in India.
(8) Science in Industry in India.
(9) Finance of Research in India.
(10) The Budget of Science in India.

For topics mentioned in Parts I and II of the syllabus Professor Bernal's book may be prescribed as a text book. It is a comprehensive treatise and is undoubtedly the best book on the subject. For supplementary readings small treatises like New Scientific Achievements by G. S. Ranshaw (Burke Publishing Company), Science News Nos. I & 2 and Science in Peace (these three being Penguin Books), and books on General Science may be prescribed.

For topics mentioned in Part III it is recommended that the Department of Scientific Research, Government of India, should undertake compilation and publication of a volume dealing with not only all the items mentioned therein but also such other useful scientific information as the Department might think suitable for inclusion in it.

In a discussion with Professor Bernal in January 1950, when he visited India in connection with the meeting of the Indian Science Congress Association, it was felt that he thought that some of the topics mentioned in part II might be too ambitious for study in India, more so after the Second World War, unless they are studied for the purpose of obtaining a historical background of the modern social problems in relation to science. For this reason Professor Bernal suggested that a more careful study of the topics discussed in his recent book 'The Freedom of Necessity' (published in 1949) would be desirable. He emphasized that the following topics, if carefilly studied, would give a new outlook to the students of science. They are mentioned below as Part IV of the syllabus.

Part IV.

(1) Man and the World
Belief and Action
The Challenge of our Time
(2) The Relevance of Science
The Effect of Social Forms on Social Science
Transformation in Science
Science and Liberty
Liberty and the Individual.

(3) Science and the Humanities
Science Teaching and General Education

(4) Science and the Arts

(5) Science in Economics and Politics.

(6) The Atomic Age.

Moreover Professor Bernal would like all Engineering students to know the following:—

(1) Economic and Aesthetic Aspects of Engineering.

(2) Social Aspect of Engineering.

(3) General Social History of Science with special reference to food, agriculture and electrical industry of the country.

Discussion groups of scientists and science graduates who will ultimately be teachers of 'Science and its Social Relations' should also be arranged by the Universities in India. Unless study groups are formed it will be difficult to get suitable teachers on the subject from among the teachers of science in colleges. Further it is suggested that each university and every college teaching science subjects even up to the B.Sc. course should make arrangements for teaching some, if not most of the topics included in the course outlined above.

At the end of a fairly comprehensive study of the projects and topics included in the syllabus on 'Science and its Social Relations' the scientists and scientific workers should be able to say in the words of Professor Bernal:—"We have seen science as an integral part both of the material and economic life of our times and of the ideas which guide and inspire it. Science puts into our hands the means of satisfying our material needs. It gives us also ideas which will enable us to understand, to co-ordinate and to satisfy our needs in social sphere. Beyond this science has something as important though less definite to offer; a reasonable hope in the unexplored possibilities of the future, an inspiration which is slowly but surely becoming the dominent driving force of modern thought and action."

Ultimately the scientists and technicians, while enlisting themselves as members of an International Federation should be able to take an oath, in the words of Dr. Weltfish as follows:—

"I pledge myself that I will use my knowledge for the good of humanity against the destructive forces of the world and the ruthless intent of men, and that I will work together with my fellow scientists of whatever nation, creed or colour, for these our common ends."

RESOULTION OF SECTIONAL COMMITTEE
SECTION OF ENGINEERING AND METALLURGY

1. Since planning presumes the conception and detailing of an objective.

2. Since Engineering implies the designing and execution of the objective with full cognizance of available material and human resources.

3. Since the Government of India has initiated and encouraged many multipurpose projects, to conserve our depleting resources and to develope new ones, and to raise the cultural standard of the citizen of India.

4. Since raising the Cultural standard implies the availability of nourishing food, better clothing, adequate housing, improved hygiene and health facilities and universal education for the citizens of India.

5. Since the achievement of the above objectives compels accelarated productivity agriculture, industry and increased activity in trade.

6. And, since to achieve optimum results integration and co-ordination of the diverse plans are imperative, to give effect to the objectives stated above.

Therefore be it resolved that the Indian Science Congress recommends the immediate establishment of a Federal Planning Commission and to provide the highest financial priority to the various multipurpose projects initiated by the Government of India so far.

SECTION OF PSYCHOLOGY & EDUCATIONAL SCIENCES

1. The Sectional Committee of Psychology & Educational Sciences considered the suggestion of the President for forwarding a Council of Psychological Research for the purposes:

"For this purpose a Council of Psychological Research may be constituted which will meet at least once a year to review research work done by various workers in the field, to offer facilities to them and to coordinate their activities. It will publish a report detailing the main lines of research carried on by psychologists at various centres. In addition, it may undertake some other task such as to (*a*) prepare a dictionary of psychological terms in the national language, (*b*) maintain a list of workers, (*c*) publish research monographs, (*d*) encourage research in the design of apparatus and instruments, (*e*) and to develope contact with psychologists in other countries, try to invite experts and organise special courses and lectures by visiting and exchange professors from abroad and in the country".

2. Resolved that a Committee of the following be constituted to work and submit a report:

1. Dr. N. S. N. Sastry, Bangalore, 2. Principal, T. K. N. Menon, Baroda, 3. Prof. S. K. Bose, Calcutta, 4. Major Davis, Ranchi, 5. Dr. B. L. Atreya, Banares. 6. Prof Kali Prasad, Lucknow.

II RULES AND REGULATIONS

RULES

1. The name of the Association shall be the Indian Science Congress Association and its objects shall be the advancement of Science in India by the annual holding of a Congress and the doing of all such thing as are incidental or conducive to the above object, including—

(*a*) the holding and management of funds and property;
(*b*) the acquisition of rights and privileges necessary or convenient for the object of the Association;
(*c*) the management, development, improvement, disposal and sale of all and any parts of the property of the Association.

2. The Association shall consist of Ordinary Members, Sustaining Members, Benefactors, Honorary Members and Session Members.

3. Ordinary Members of the Association shall have the right to contribute papers for reading at the Session of the Congress, to receive free of charge all publications issued by the Association, and to fill any office in the Association on being duly elected thereto.

4. The annual subscription of Ordinary Members shall be Rs. 12. The subscription shall become due on the 1st February of each year and shall only be effective as payment for Ordinary Membership subscription if received before the 15th July of the year.

5. Any Ordinary Member may compound for the payment of all future annual subscriptions by the payment in a single sum of Rs. 150.

6. Any Ordinary Member agreeing to pay one aditional subscription (Rs. 12) during his period of membership shall be called Sustaining Member.

7. Any person paying a lump sum of Rs. 500 or more or any institution paying a lump sum of Rs. 10,000 or more shall be a Benefactor of the Association, subject to the approval of the Executive Committee. Benefactors shall have all rights and privileges of Ordinary Members during their lifetime.

An institutional Benefactor shall have the right to nominate one person as Ordinary Member of the Association.

8. Honorary Member shall have all the rights and privileges of Ordinary Members, Honorary Members, the number of whom shall be limited to fifteen at any one time, shall be persons eminent for their contributions to science or persons who have rendered conspicuous services to the cause of science in India.

Honorary Members shall be nominated by the Executive Committee subject to confirmation by the Council and the General Committee at its annual meeting. Not more than one Honorary Member shall be elected in any year.

9. There shall be three classes of Session Members:—

(*a*) Full Session Member—subscription Rs. 12 per Session.
(*b*) Associate Session Members—subscription Rs. 5 per Session.
(*c*) Student Session Members—subscription Rs. 2 per Session.

10. Full Session Members shall have the right to contribute papers for reading at the Session of the Congress, and to receive free of charge all publications issued by the Association relating to the Session of the Congress of which they are Members.

Associate and Student Session Members shall have the right to submit papers for reading at the Session of the Congress of which they are Members, provided such papers be communicated through an Ordinary or an Honorary Member of the Association.

A Student Member shall before admission be duly certified by the head of his or her institution to be a *bonafide student.*

Associate and Student Session Members shall receive free of cost the Abstracts of Paper contributed for the Session of which they are members.

11. The official year of the Association shall commence from the 1st of February.

12. There shall be Officers of the Association consisting of the members of the Executive Committee and Presidents and Recorders of Sections.

13. Only Ordinary and Honorary Members shall hold office in the Association.

14. The term of office of all Officers of the Association except the President shall commence from the beginning of the official year and shall extend until the assumption of office by their successors, appointed in accordance with the provisions of these Rules. The President shall assume office on the opening day of the Annual Congress following the one at which he is appointed, and shall continue to hold office until the assumption of office by his successor.

15. There shall be an Executive Committee which shall carry on the administrative work of the Association and submit such questions as it thinks desirable to a General Committee at its Annual Meeting during the Session of the Congress or at a Special Meeting of which due notice shall have been given.

16. The Executive Committee shall consist of the President, the President-elect for the following year, the two General Secretaries, the Treasurer and ten Members, Ordinary or Honorary, elected by the General Committee. For the purpose of this election any Ordinary or Honorary Member may propose the name of an Ordinary or an Honorary Member for election to the Executive Committee. Such proposal must

be seconded by another Ordinary or Honorary Member and must reach the General Secretary before the 15th September. The Executive Committee shall circulate the names, together with such other names, not exceeding three, as it may suggest, to all Ordinary and Honorary Members for election by ballot. The ballot papers will be scrutinized by the President or his nominee and the General Secretaries, and the results of the ballot will be announced at the meeting of the General Committee.

Ordinary or Honorary Members, who have been elected members of the Executive Committee for three successive years, shall not be eligible for election as members for a period of two years after the completion of their term of appointment.

The Executive Committee shall co-opt as member at least one and not more than two Local Secretaries for the ensuing Session of the Congress.

17. The Executive Committee shall have full power to transact all business in cases of emergency, notwithstanding any limitations hereinafter laid down, and to deal with all matters not otherwise provided for in these Rules, including the making of such Regulations as may appear conducive to the good administration of the Association and the attainment of its objects; provided always that such Regulations be not inconsistent with anything contained in these Rules, that they be reported for the information of the next meeting of the General Committee, and that they be subject to rescission or alteration by the Executive Committee or by any meeting of the General Committee.

18. There shall be a General Committee which shall consist of all Ordinary and Honorary Members of the Association.

19. The General Committee shall meet at least once during each Session of the Congress, preferably, in the middle of the Session.

20. There shall be a Council which shall consist of all Members of the Executive Committee, and all such Ordinary and Honorary Members of the Association as have held office as President, General Secretary, Treasurer, or Managing Secretary of the Association, the Sectional Presidents for the ensuing Session, and and in addition seven Members of the Association, Ordinary or Honorary, elected by the General Committee. For the purpose of this election any Ordinary or Honorary Member may propose the name of an Ordinary or an Honorary Member for election to the Council. Such proposal must be seconded by another Ordinary or Honorary Member and must reach the General Secretary before the 15th September. The Executive Committee shall circulate these names, together with such other names, not exceeding three, as it may suggest, to all Ordinary and Honorary Members for election by ballot. The ballot papers will be scrutinized by the President or his nominee and the General Secretaries, and the results of the ballot will be announced at the meeting of the General Committee.

21. The function of the Council shall be to act as a body of advisers to be consulted by the Executive Committee on important questions of policy or scientific import.

2. There shall be a President who shall be nominated by the Executive Committee and whose nomination shall be submitted to the General Committee at its Annual Meeting during the Session of the Congress for confirmation.

23. There shall be two General Secretaries (one of whom shall be resident in Calcutta) who shall be nominated by the Executive Committee and whose nomination shall be submitted to the General Committee at its Annual Meeting during the Session of the Congress for confirmation.

24. There shall be a Treasurer who shall be nominated by the Executive Committee and whose nomination shall be submitted for confirmation to the General Committee at its Annual Meeting during the Session of the Congress.

25. The term of office of each General Secretary and of the Treasurer shall be for a period of three years following the confirmation of the appointment by the General Committee. They shall not be eligible for re-election to the office for a period of three years after the termination of their appointment.

26. In the event of a vacancy amongst the General Secretaries and the Treasurer occurring between two Session of the Congress the Executive Committee shall have power to appoint a General Secretary or the Treasurer for the period up to the termination of the next Session of the Congress.

27. There shall be a Local Secretary or Local Secretaries for each Session of the Congress who shall be appointed by the Executive Committee.

28. There shall be a Local Committee for each Session of the Congress which shall be appointed by the Executive Committee.

29. The Local Secretary, or Secretaries, and the Local Committee shall jointly, on behalf of and in consultation with the Executive Committee, make all necessary arrangements for the holding of the Session of the Congress.

30. For the purpose of scientific deliberations during the Session of the Congress there shall be such Sections corresponding to different branches of science as may from time to time be constituted by the General Committee on the recommendation of the Executive Committee. It shall be competent for any Section after the first day's meeting to hold its scientific meetings in sub-sections for the purpose of dealing separately with different groups of papers submitted to that Section. A separate Chairman may be appointed by the Sectional President in consulation with the Sectional Committee to preside over each sub-section.

31. There shall be in each Section a President and a Recorder, who shall be appointed by the Sectional Committee in accordance with the procedure laid down in Regulation 1(8). Where this procedure has not been followed, those appointments shall be made by the Executive Committee. The appointments shall be placed for confirmation before the General Committee. In addition there shall be Sectional Correspondent and a Local Sectional Secretary, who shall be appointed by the Executive Committee.

32. In each Section there shall be Sectional Officers, namely, a President, a Recorder, a Sectional Correspondent, and a Local Sectional Secretary. The President and the Recorder shall be the chief executive officers of the Section. They shall have power to act on behalf of the Sectional Committee in any matter of urgency which cannot be brought before the Sectional Committee for consideration, and they shall report such action to the Sectional Committee at its next meeting.

The work of each Section shall be conducted by a Sectional Committee which shall be constituted as follows:—

(*a*) Sectional Officers.
(*b*) All Ordinary and Honorary Members of the Association who have been Presidents or Recorders of the Section.
(*c*) Two Members of the Association, Ordinary or Honorary, elected by the General Committee at its Annual Meeting during the Session of the Congress.

The Sectional President shall preside over all meetings of the Section and of the Sectional Committee. He shall be the convener of the meetings of the Sectional Committee. His ruling shall be final on all points of order that may arise.

The Sectional Recorder shall act as the Secretary of the Sectional Committee, and shall maintain a proper record of the proceedings of the Sectional Committee and of the Section in a book provided for the purpose. He shall be responsible for the punctual transmission to the General Secretary of the recommendations adopted by the Sectional Committee, and of resolutions adopted by the Section.

The Sectional Correspondent shall be resident at the headquarters of the Association, and shall be responsible for preparing for the press the material relating to his Section, according to the instructions of the Sectional President.

The Local Sectional Secretary shall be resident in the locality where the Annual Session is held, and shall be responsible for all local arrangements for the work of his Section, and for arranging the Sectional excursions in consultation with the Local Secretaries.

33. Sectional Committee shall meet on the opening day of each Session of the Congress, and daily thereafter during the Session before the meeting of the Session unless otherwise determined at a meeting of the Sectional Committee.

In the absence of the Sectional President from any of its meetings the most senior member of the Sectional Committee present shall take the chair.

In their meeting on the opening day they shall,

(*a*) elect a Sectional President and a Sectional Recorder for the ensuing year in accordance with the procedure laid down in Reg. 1 (8) ;

(*b*) determine the detailed arrangements for the Sectional meetings;

(*c*) select the papers to be read and discussed;
and in their meetings during the Session they shall also,

(*d*) nominate a Sectional Correspondent and a Local Sectional Secretary for the ensuing year for the consideration of the Executive Committee;

(*e*) determine the contents of the Sectional records in the Proceedings in accordance with Rule 34(*e*) ;

(*f*) consider means of improving the scientific work of the Section, and make suggestions to the Executive Committee whenever considered necessary;

(*g*) select topics for discussions at the next Session of the Congress and make necessary arrangements (*i*) through the President of the Section concerned for discussions within a Section, and (*ii*) through the Sectional President who has initiated the proposal for a discussion in which more than one Section will participate.

34(*a*) All papers submitted for reading at the next Session for the Congress shall be forwarded to the General Secretary so as to reach him not later than September 15th of the calendar year preceding the Session of the Congress at which the papers are intended to be read, provided that this date may be changed by the Executive Committee for special reasons.

(*b*) Any paper submitted for reading at the Section of the Congress shall be accompanied by an abstract in triplicate.

(*c*) All papers submitted for reading at a Session of the Congress shall be checked by the Sectional Correspondent concerned or by such person or persons appointed by the General Secretary. The paper together with a copy each of the abstracts shall then be sent to the Sectional President concerned for refereeing and acceptance. Decisions with regard to acceptance or rejection of any paper shall be final and all reports confidential.

(*d*) No paper published elsewhere shall be accepted.

(*e*) Only abstracts of the paper received by the General Secretary before September 15th in accordance with Rule 34(*a*), (*b*) and (*c*) shall be printed in Part III of the Proceedings. In exceptional circumstances, abstracts of papers received after that date and read before the Section, if specially recommended by the Sectional Committee, may be printed in Part IV.

35. The Proceedings of the Indian Science Congress Association shall be published in one volume in four separate parts, as follows:—

I. To contain the list of officers, the Proceedings of the opening meeting (except the General President's Address) and all official matters.

II. To contain the Presidental Addresses. To be distributed to those present at the meeting after the addresses have been delivered, and to absent Ordinary, Honorary and Full Session Members by post after the meeting.

III. To contain the abstracts of papers to be read before the Sections which are received before September 15th in accordance with Rule 34(*a*). No abstracts shall be included in this volume from authors who have not enrolled themselves as Members of the Association. To be distributed in advance of the meeting to all Members of the Association.

IV. To contain the discussions, the abstracts accepted in accordance with Rule 34(*e*), the list of members and the index.

36. The following procedure shall be observed for the making of any addition to or alteration in the Rules of the Association:—

(*i*) Proposals for additions to and alternations in the existing Rules may be placed at any time before the General Committee by the Executive Committee.

(*ii*) (*a*) Proposals for additions to and alternations in the existing Rules by any Ordinary or Honorary Members of the Association shall be sent to one of the General Secretaries so as to reach him two full months before the meeting of the General Committee in which they are to be moved.

(*b*) One of the General Secretaries shall circulate such proposals to all Ordinary and Honorary Members of the Association at least one full month before the General Committee.

(*c*) Any amendments to the proposals shall be sent by any Ordinary or Honorary Member of the Association to one of the General Secretaries so as to reach him at least a fortnight before the meeting of the General Committee.

(*d*) The proposals together with any amendments shall be brought up before the meeting of the General Committee at the Annual Meeting during the Session of the Congress together with any remarks of the Executive Committee and declared carried if accepted by a two-thirds majority of the constitutent Members present and voting at the meeting.

(*Adopted* the 5th January, 1931. *Revised* the 15th January, 1935, the 6th January, 1936, the 5th January, 1937, the 8th January, 1939, the 6th January, 1940, the 5th January, 1942, the 4th January, 1943, the 5th January, 1945 and the 5th January 1948).

REGULATIONS

1. SECTIONAL OFFICERS

(1) The President delivers a Presidental Address of which ordinarily the cost of printing 16 pages of the Proceedings in its usual form shall be borne by the Indian Science Congress Association and any author exceeding the limit shall bear the extra cost, provided that in no case the Presidential Address shall exceed 25 pages. The time available for delivery of the Presidental Address shall usually not exceed 25 minutes. The manuscript of the address, ready for the press, should be received by the General Secretary before October 15th of the calendar year preceding the Session of the Congress at which the address will be delivered, provided that this date may be changed by the Executive Committee for special reasons. It should be accompanied by 12 copies of a short popular summary (about 500 words) for issue to the lay press. The time and date of the delivery of the President's Address will be communicated before the meeting of the Congress. No two Presidential Addresses will be delivered at the same time.

(2) The President shall be entitled to receive 30 copies of his address without charge, and additional copies at the cost of reproduction.

(3) Railway fares, postage, clerical or other expenses incurred by the Sectional Presidents will not be paid by the Association.

(4) The following procedure is adopted for the collection of papers for the Sections:—

About the middle of April a number of copies of a printed circular will forwarded to the President of each Section who may arrange to send these to workers in that branch of science with which his Section is concerned, requesting them to contribute papers for reading before the next meeting of the Congress.

The circular will contain a clause inviting such workers as are not yet Ordinary Members of the Association to join as such. Particular note should be taken of the fact that no new Ordinary Members are enrolled after the 15th July of the year.

In the case of joint papers, each author must be a Member of some category.

(5) The President referees, either in person or by proxy, the papers received for reading before his section in accordance with Rule 34.

Abstracts should be limited, except in very special cases, to about 200 words. Long abstracts should be reduced by the President. References to literature in abstracts should be avoided as far as possible and when given should conform to the system of abbreviation used by the Association.

The contents of all abstracts should be carefully checked by the Sectional Correspondent concerned or by such person or persons as appointed by the General Secretary and the abstracts shall then be sent to the Sectional President for his final scrutiny and approval.

Joint discussions on related papers may be held. Authors of papers should be informed of time allotted by the President to the reading of their papers. An author contributing more than one paper should be asked to specify which of them he would prefer to read at the meeting.

(6) The President, in consultation with the Local Sectional Secretary, shall make arrangements for such local Sectional excursions as seem desirable. Due notice shall be given to the General Secretaries of all such arrangements.

(7) The President and the Recoder should, in consultation with other members of the Sectional Committee, make proposals to the General Secretary regarding the programme of the Section. Such proposals should reach the General Secretary not later than the 1st November, so as to enable the necessary details to be entered in the programme. General discussions on questions of importance, held either by a single Section or jointly by two or more Sections, should be encouraged.

The Sectional Presidents concerned shall communicate to the General Secretary before the end of July the titles of such discussions, the names of the speakers and such further information as may be considered necessary.

The Papers, together with three copies of abstracts, to be read by the contributors at a discussion shall be sent to the General Secretary on or before th 15th September of the preceeding calendar year by the Sectional President concerned.

The materials relating to a discussion, in a form ready for the press, shall be communicated to the General Secretary within a month from the date on which the discussion takes place; the material not received by the General Secretary within this period shall not be published.

The President and the Recorder of the Section arranging a discussion shall carry out the necessary correspondence throughout the year during which they hold office.

(8) Early in November copies of a printed form will be issued to Presidents of Sections for circulation to members of the Sectional Committees requesting them to nominate a President and a Recorder for the ensuing meeting for consideration by the Sectional Committee. Such proposals shall be accompanied by a statement of qualifications of the nominees for the office and their willingness to accept the same if elected thereto.

During the first week of December, the President of each Section shall circulate all such proposals received by him, together with the statements of qualifications, to the members of the Sectional Committee and request them to nominate by ballot one member for each office from among the list circulated, the ballot papers being received by him up to the 20th December.

At the first meeting of the Sectional Committee held on the opening day, the ballot papers shall be opened and scrutinized as the Chairman shall direct and the result communicated to the Executive Committee for consideration, together with a complete record of the Proceedings in this connection.

(9) The duties of the Sectional Correspondent and of the Local Sectional Secretary are given in Rules 32 and 34(*c*).

(10) All persons entitled to be members of the Sectional Committee should enrol themselves without delay as Ordinary Members if not already so enrolled and should inform the General Secretary of the payment of their subscription when accepting the appointment.

(11) The General Secretary should be consulted whenever any question arises not dealt with in these regulations.

II. LOCAL ARRANGEMENTS

In accordance with the Rules of the Association, the Local Secretaries and the Local Committee shall jointly, on behalf of and in consultation with the Executive Committee, make all necessary arrangements for holding the Session of the Congress.

The following arrangements have to be made:—

A. Accomodation for the Scientific Meetings

(1) A large hall should be available for (*a*) the President's address on the opening day, and (*b*) for the evening lectures. Both (*a*) and (*b*) are open to the public free of charge. A projection lantern with an operator should be available in this room, and it is great advantage if loud speakers can be installed.

(2) Rooms for the meeting of the different Sections of the Congress should be provided and suitably furnished. An epidiascope with an operator should be provided in each sectional room. All the rooms should be as far as possible in close proximity. The following are the Sections of the Congress:—

Mathematics, Statistics, Physics, Chemistry, Geology and Geography, Botany, Zoology and Entomology, Anthropology and Archæology, Medical and Veterinary Sciences, Agricultural Sciences, Physiology, Psychology and Educational Sciences, and Engineering and Metallurgy.

(3) A Reception room should be provided in which members can get information, write letters, etc. The Local Secretaries' Office should be as near as possible to this room. An arrangement should be made with the Postmaster-General to have a temporary Post Office in this room for all letters addressed to members C|o. The Indian Science Congress to be delivered here. The Indian Science Congress Post Office should be situated as near as possible to the Reception room.

(4) A room near the Reception room should be set apart for the General Secretaries' Office, which will be opened therein from the 31st December.

(5) Provision should be made for lunch in European and Indian styles at moderate charges near the Reception room.

B. Accommodation for Visiting Members

The Local Secretaries should send out, not later than the end of November, a printed circular to all members enrolled, asking them if they desire that accommodation should be arranged for them. It is desirable, as far as possible, to provide private hospitality for the President, Sectional Presidents and Officers of the Congress. In this circular information should be given regarding the types of accomodation available, with the charges, and the nature of the climate during the Session. The Local Secretaries will receive periodically from the General Secretary list of members enrolled at headquarters.

C. Programme of the Meeting

(1) (*a*) The Sections of the Congress meet daily in the morning generally from 9-30 A.M.

(*b*) Presidential Addresses of the Sections shall commence from 9-30 A.M.

(*c*) There should be no afternoon Presidential Addresses of the Sections.

(*d*) Symposia or joint discussions will be held either in the morning or from 2 P.M.

(2) Public lectures are arranged by the Executive Committee, and are given at 6 P.M. or 6-30 P.M.

(3) A printed guide with a map of the locality in which the Congress is held should be prepared for distribution to members on the opening day. Only Ordinary, Honorary and Full Session Members are entitled to the Guide Book free of cost. A small charge not exceeding Re. 1|- (to be fixed by the Local Committee) may be made to other members desiring to have a copy. The Guide Book should contain a summary of information concerning the scientific and educational activities and a short history of the locality, in addition to general information likely to be of use to visitors.

(4) Arrangements should be made for giving due publicity to the activities of the Congress, both before and during the meeting.

(5) A list of members with their local addresses where known should be printed and distributed on the opening day. A supplementary list should be typed and posted in the Reception room and maintained up-to-date. The Local Secretaries shall arrange for this.

(6) A provisional programme of social engagements should be drawn up by the Local Secretaries and sent to the General Secretary by the 15th November. It is essential that this be sent in time, as it has to be printed and distributed with the abstracts by the first week of December.

The General Secretary will make arrangements for printing the programme drafted as above and distributing those to members enrolled at the time of the distribution of the abstracts.

The final programme shall be printed locally by Local Committee in time for the opening of the Session.

D. General

(1) Numbered badges for members of the Congress will be sent by the General Secretary to the Local Secretaries for distribution on the opening day of the meeting. The badges should bear numbers corresponding to the enrolment numbers. There should be additional badges for Officers.

(2) Members of the Local Reception Committee who have made substantial contributions to the funds of the Local Committee may be given complimentary tickets to attend the meetings.

(3) An audited copy of the accounts of the Local Committee should be sent to the General Secretary not later than the 30th April, following the Session, for inclusion in the Proceedings of the Session. It is desirable that the Local Committee should contribute any surplus to the reserve fund of the Association.

(4) Twelve copies each of all local publications connected with the Congress (Guide Book, final programme, notices, cards, etc.) should be sent to the office of the Association for record at the conclusion of the meeting.

(5) Applications for membership will ordinarily be dealt with by the General Secretary at the Office of the Association up to the 15th December. After that date applications for membership will be forwarded to the Local Secretaries, who will open a separate account for the sale of membership tickets. The amount thus realized, together with unsold tickets, should be forwarded to the General Secretary immediately after the close of the Congress.

III. FINANCIAL

(1) The accounts of the Association shall be audited once a year and the books closed on the 30th November each year for this purpose.

(2) The audited accounts shall be placed before the General Committee at the Annual Meeting with the observations, if any, of the Executive Committee.

(3) Sanction for all payments for amounts exceeding Rs. 100 shall be obtained from the Finance Committee which shall consist of the General Secretaries, the Treasurer and one Ordinary or Honorary Member resident in Calcutta who shall be nominated by the Executive Committee.

(4) Amounts received on account of Life Membership Subscription shall be credited to the Reserve Fund of the Association.

IV. ELECTION OF REPRESENTATIVES OF ASSOCIATION BY THE EXECUTIVE COMMITTEE

(1) A letter shall be issued asking for nominations giving a last date therefor.

(2) The proposer should ascertain whether the person he proposes is desirous of serving in that particular capacity.

(3) After the nominations have been received the names should be circulated in a ballot paper and the date for return should be fixed two weeks after the ballot paper is sent out.

V. NOMINATION OF GENERAL PRESIDENT

(1) The General Secretary shall invite nominations for the office of General President of the Association, two years in advance, by a circular letter to the members of the Council, not later than the 15th of October. Such circular shall include a list of the General Presidents of the past 15 years, and the branches of science in which they had specialized.

Nominations shall reach the General Secretary not later than the 15th of November.

(2) The General Secretary shall circulate the nominations received to the members of the Executive Committee for expression of opinion on or before the 30th November. Such opinions shall reach the General Secretary not later than the 15th December.

(3) The nominations, together with the views of members thereon, shall be placed for decision before a meeting of the Executive Committee to be held on the day previous to the commencement of the Session of the Congress.

(*Adopted* the 5th January, 1937. *Received* the 8th January, 1939, the 6th January, 1940, the 6th January, 1941, the 5th January, 1942, the 4th January, 1943 and the 5th January, 1945).

STATEMENT OF ACCOUNT.

THE INDIAN SCIENCE

1, PARK STREET,

Balance

as at 30th

LIABILITIES :

	Rs.	As.	P.	Rs.	As.	P
General Fund:						
As per last Account	8,733	12	11			
Add, this year being excess of Income over Expenditure	14,386	6	0			
*Excess of Income over expenditure (Foreign Scientists)	9,307	14	9			
Rs.	32,428	1	8			
Less, transferred to Reserve Fund	708	0	0			
Rs.	31,720	1	8			
Add excess expenditure on Foreign Scientists at 34th Session now recoverd	6,946	1	0	38,666	2	8
Reserve Fund:						
As per last account	20,320	15	4			
Adi, transferred from General Fund	708	0	0			
Interest earned	259	0	0			
	21,287	15	4			
Less, Bank charges		1	0	21,287	14	4
Carried Over				59,954	1	0

CONGRESS ASSOCIATION

LCUTTA.

t

nber, 1949.

ASSETS :

	Rs.	As.	P.	Rs.	As.	P
Furniture & Fittings:						
As per last Account	2,594	8	0			
Add this year	68	1	0			
Rs.	2,662	9	0			
Less, Depreciation @ 5% on Rs. 2,594|8|- ..	129	11	0	2,532	14	0
Typewriter (as per last account)				650	0	0
Outstanding Account (as per last A|c) Burmah Shell				636	0	0
Advance (adjustable)				50	0	0
Reserve Fund Investment:						
4% Loan 1960-70 (Face value 5000|-)						
3% Victory Loan 1959-61 (Face value 2000|-)						
12 Years National Savings Certificate (5000|-) at cost	12,977	9	10			
Imperial Bank of India Reserve Fund A|c ..	8,310	4	6	21,287	14	4
Carried Over				25,156	12	4

THE INDIAN SCIENCE

1, PARK STRE

Bal

as at

	Rs.	As	P.	Rs.	As.	P
Brought forward				59,954		
LIABILITIES:						
Govan Brothers	289	6	0			
Indian Statistical Institute	416	0	6			
Great Eastern Hotel	34	0	0			
Printing	324	6	0			
Postage	399	2	6			
Establishment	730	0	0			
Contingency	47	13	3			
Telephone	46	2	3			
Rent	300	0	0			
Expenses at 36th Session	1,527	0	0	4,113	14	6
Suspense: Dr. M. S. Vallatra				1,149	0	0
*There was a deficit amounting to Rs. 9,921-10-3 as per last year's account which may now be recovered in part out of this surplus						
			Rs.	65,216	15	6

I have audited the Balance Sheet as at 30th November, 1949, and the annexed Income and Expenditure account also the Statement of expenditure on Foreign Scientists of the Indian Science Congress Association for the year ended 30th November 1949 with the books and vouchers of the Association and have obtained all the information and explanations I have required. In my opinion the Balance Sheet and Income and

CONGRESS ASSOCIATION

CALCUTTA.

Sheet (Contd.)

November, 1949.

Brought forward				25,156	12	4
Cash-in-hand and at Bank:						
	Rs.	As.	P.			
In hand	75	0	0			
Imperial Bank of India	* 39,985	3	2	40,060	3	2

*A. This includes Rs. 9,307-14-9 to be refunded to Govt. of India on account of expenses of Foreign Scientists received in excess ..

B. Rs. 15,000|- being the grant for the year 1949-50 was received within this year .. ..

Rs.	65,216	15	6

Expenditure account are properly drawn up and the Balance Sheet exhibits the true and correct view of the Association's affairs as on that date according to the best of my information and explanations given to me and as shown by the books of the Association.

Sd|-. S. N. Chatterjee

Chartered Accountant,
Auditor

20, Strand Road, Calcutta
21st December, 1949.

THE INDIAN SCIENCE

1, PARK STREET,

Statement of Govt. Grant and

at 36th Session

	Rs.	As.	P.	Rs.	As.	P.
To Hotel Charges	4,593	6	6			
„ Air Fares in India	2,521	0	0			
„ Raliway Fares	368	12	6			
„ Air Fares to and from India	22,162	13	6			
„ Allowances	400	0	0			
„ Sundry Charges	483	1	3			
„ Taxi Hire	688	7	0			
Rs.	31,217	8	9			
Less Provision made in last Year's A|c. ..	27,890	12	6	3,326	12	3
To Excess Air passage at 36th Session				5,619	4	0
„ Provision for expenses at 36th Session, pucca bills for which have not yet been received ..				1,527	0	0
„ Excess expenditure at 34th Session not provided for in last year's account now recovered, transferred to General Fund				6,946	1	0
„ Excess of Income over expenditure				9,307	14	9
			Rs.	26,727	0	0

CONGRESS ASSOCIATION

CALCUTTA.

Expenditure on Foreign Scientists at Allahabad, 1949.

	Rs.	As.	P.	Rs.	As.	P
By Government Grant				26,727	0	0
			Rs.	26,727	0	0

THE INDIAN SCIENCE

1, PARK STREET,

Income & expenditure

for the year ending

	Rs.	As.	P.	Rs.	As.	P
To Establishment				6,479	13	0
„ Postage				2,457	2	0
„ Contingency				738	9	0
„ Printing				15,622	9	0
„ Telephone				239	5	3
„ Binding Charges				317	15	0
„ Advertising				70	10	0
„ Travelling				1,045	6	9
„ Stationary				418	6	0
„ Rent				900	0	0
„ Depreciation on Furniture				129	11	0
„ Bank Charges				81	6	0
„ Excess of Income over Expenditure ..				14,386	6	0
				Rs. 42,887	3	0

CONGRESS ASSOCIATION

CALCUTTA.

Account

30th November 1949.

	Rs.	As.	P.	Rs.	As.	P
By Membership Subscription	24,760	0	0			
„ Publication Sales	1,013	3	0			
„ Government of India Grant	15,000	0	0			
„ Miscellaneous	31	0	0			
„ Donation	51	0	0			
„ National Institute of Science	1,450	0	0			
„ Life Membership	582	0	0	42,887	3	0
Rs.				42,887	3	0

THE INDIAN SCIENCE

1, PARK STREET,

Estimated Budget for Revenue Income and Expenditure

EXPENDITURE

	Estimated for 1948-49			Actuals for 1948-49				Estimated for 1949-50		
1. Revenue Expenditure:	Rs.	As	P	Rs.	As	P		Rs.	As	P
Establishment (Staff salary including D.A.)	13,350	0	0	6,479	13	0	(1)	14,000	0	0
Printing & Paper	31,000	0	0	15,622	9	0	(2)	20,000	0	0
Rent (including proposed Library). ..	2,100	0	0	900	0	0		2,100	0	0
Postage	2,000	0	0	2,457	2	0		2,650	0	0
Stationery & Stores	500	0	0	418	6	0		600	0	0
Telephone & Electricity	300	0	0	239	5	3		400	0	0
Travelling (including venue of the session and conveyances)	1,500	0	0	1,045	6	9	(3)	2,000	0	0
Travelling allowances to the members of the Executive Committee and Council to attend meeting	5,000	0	0	Nil.			(4)	5,000	0	0
Miscellaneous and Contingency including Railway Freight, to venue of the session, Bank charges, Depreciation ..	1,000	0	0	1,338	3	0		2,000	0	0
Audit fee	200	0	0	Nil.			(5)	200	0	0
Excess of Income over Expenditure ..				14,386	6	0				
Rs.	56,950	0	0	42,887	3	0		48,950	0	0

(Carried over)

CONGRESS ASSOCIATION

CALCUTTA.

for the year ending on 30th November, 1950.

INCOME

	Estimated for 1948-49			Actuals for 1948-49			Estimated for 1949-50		
1. Revenue Income:	Rs.	As	P	Rs.	As	P	Rs.	As	P
Membership Subscription	25,000	0	0	24,760	0	0	26,000	0	0
Publication Sales	1,000	0	0	1,013	3	0	1,200	0	0
Government of India Grant	15,000	0	0	15,000	0	0	15,000	0	0
Grant From N. I. of Science	1,000	0	0	1,450	0	0	1,450	0	0
						(6)			
Miscellaneous, Donation, Life Membership				664	0	0			
Rs.	42,000	0	0	42,887	0	0	43,650	0	0

(Carried over)

THE INDIAN SCIENCE

1, PARK STREET,

Estimated Budget for Revenue Income and Expenditure

EXPENDITURE

	Estimated for 1948-49			Actuals for 1948-49			Estimated for 1949-50		
	Rs.	As	P	Rs.	As	P	Rs.	As	P
Brought forward	56,950	0	0	42887	3	0	48,950	0	0
2. *Capital Expenditure*:									
Furniture and office equipments for Library room, Reserve Fund Investment with Imperial Bank of India ..	5,000	0	0	259	0	0	15,000	0	0
Rs.	61,950	0	0	43,146	3	0	63,950	0	0

CONGRESS ASSOCIATION

CALCUTTA.

for the year ending on 30th November, 1950.

INCOME

	Estimated for 1948-49			Actuals for 1948-49			Estimated for 1949-50		
	Rs.	As	P	Rs.	As	P	Rs.	As	P
Brought forward	42,000	0	0	42887	0	0	43,650	0	0
2. *Capital Income*:									
							(7)		
Interest on Reserve Fund Investment ..	475	0	0	259	0	0	500	0	0
Rs.	42,475	0	0	43,146	3	0	44,150	0	0
Deficit.	19,475	0	0				19,800	0	0
Rs.	61,950	0	0	43,146	3	0	63,950	0	0

1. Includes provision for a Secretary and Provident Fund contribution.

2. Large stock of paper was brought forward from 1947-48 and was consumed in 1948-49 and as such the actuals is low compared with 1949-50 estimate.

3. It is expected that in the 37th session travelling expenses may have to be paid to office bearers as the venue of the session is situated at a greater distance than before and further it has been proposed that in future the meetings of the Executive Committee may be held in Delhi and Calcutta by rotation.

4. Increased as the venue of the session is situated at a great distance from Calcutta than before.

5. Accounts were audited this year by a member of the Association.

6. Based on estimated investment.

7. No estimate has been made as the nature of receipts is casual.

PROCEEDINGS
OF THE
THIRTY-SEVENTH
INDIAN SCIENCE CONGRESS
POONA, 1950

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ACKNOWLEDGMENT

The cost of printing the Proceedings of thirty-seventh session of the dian Science Congress Association has been in part defrayed by a gene-ous grant from the Rockefeller Foundation for the publication of results of ientific work made to us through the kindness of National Institute of iences of India.

37th INDIAN SCIENCE CONGRESS, POONA, 1950.

GENERAL PRESIDENT : PROF. P. C. MAHALANOBIS, F.R.S.

Address of the General President : 2 January 1950.

WHY STATISTICS ?

I naturally feel honoured at my election as General President. I remember, several years ago, I discussed with a friend of mine, at that time a member of the Executive Committee of this Association, the possibility of having a separate section for statistics. My friend, who has been always appreciative of the importance of statistics, readily agreed to have an informal talk with his colleagues. A little later he informed me that there was no chance of my proposal being accepted, and with a smile told me that some of his colleagues had remarked: "If statistics is to have a section, you may as well have a section for astrology." Evidently, statistics and astrology were bracketted together in the mind of many of our scientists. The forecasting of future events is, of course, a common feature; and the basis was felt to be equally unscientific. And yet, the section for mathematics was converted into the section for mathematics and statistics in 1942; a separate section was created for statistics in 1946; and this year, a person engaged in statistical work has been elected General President. I am aware I have not been accorded this honour because of my personal attainments. I accept it as a mark of recognition of the growing importance of statistics.

2. A great change has taken place in the climate of scientific and public opinion about statistics. One may ask how has this change been brought about? In other words, why is importance being increasingly attached to statistics? It may be appropriate, therefore, to try to explain: Why statistics?

DESCRIPTIVE STATISTICS

3. Historically modern statistics is the result of the fusion of two originally distinct disciplines—one primarily descriptive, concerned with the collection of data; the other essentially analytic, associated with the concepts of chance and probability. From time immemorial men must have been compiling information for peace and war. Statistics is in this sense as old as statecraft.[1] At each upsurge of social and political development or during war, there is a rapid growth and expansion of statistical practice. I shall give three examples from my own country.

---

[1] Harald Westergaard noted : "Etymologists may find the root of the word 'statistics' in the Italian word *stato*, and a *statista* would thus be a man who had to do with the affairs of the State. "Statistics" would consequently mean a collection of facts which might be of interest to a statesman, whether they were given in the form of numerical observations or not." (*Contributions to the History of Statistics*, London, 1932, p. 2).

Arthasāstra of Kautilya: 3rd Century B.C.

4. The *Arthasāstra* of Kautilya[2] claims to date from the period 321-296 B.C., that is, the Maurya period which reached its peak in the time of the great Asoka. It contains a detailed description for the conduct of agricultural, population, and economic censuses in villages as well as in cities and towns on a scale which is rare in any country even at the present time. The detailed description of contemporary industrial and commercial practice points to a highly developed statistical system. In Chapter XXXV (p. 158), instructions are given about the classification of villages. Specific directions are also given for a detailed census of land and field (p. 158):

> "It is the duty of Gopa, village accountant, to attend to the accounts of five or ten villages, as ordered by the Collector-General.
>
> "By setting up boundaries to villages, by numbering plots of grounds as cultivated, uncultivated, plains, wet lands, gardens, vegetable gardens, fences (vata), forests, altars, temples of gods, irrigation works, cremation grounds, feeding houses (sattra), places where water is freely supplied to travellers (prapa), places of pilgrimage, pasture grounds and roads, and thereby fixing the boundaries of various villages, of fields, of forests and of roads, he shall register gifts, sales, charities, and remission of taxes regarding fields.
>
> "Also having numbered the houses as tax-paying or non-taxpaying, he shall not only register the total number of the inhabitants of all the four castes in each village, but also keep an account of the exact number of cultivators, cowherds, merchants, artisans, labourers, slaves, and biped and quadruped animals, fixing at the same time the amount of gold, free labour, toll, and fines that can be collected from it (each house)."

5. In Chapter XXXVI (p. 160) similar instructions are given about the statistics of the Capital City (p. 160):

> "A gopa shall keep the accounts of ten households, twenty households, or forty households. He shall not only know the caste, gotra, the name, and occupation of both men and women in those households, but also ascertain their income and expenditure."

6. One striking feature in the *Arthasāstra* is the emphasis on the need of checking and verification by independent agents working in secret without the knowledge of the original enumerators (Chapter XXXV, p. 159):

> "Spies, under the disguise of householders (grhapatika, cultivators), who shall be deputed by the collector-general for espionage, shall ascertain the validity of the accounts (of the village and district officers) regarding the fields, houses and families of each village—the area and output of produce regarding fields, right of ownership and remission of taxes with regard to houses, and the caste and profession regarding families.
>
> "They shall also ascertain the total number of men and beasts (janghagra) as well as the amount of income and expenditure of each family."

7. Detailed instructions are given in other places about the standards of weights and measures, measurement of space and time; national accounts;

---

[2] Translated by Dr. R. Shamasastry, 3rd edition, Wesleyan Mission Press, Mysore,

and the duties of Government Superintendent in charge of multifarious departments such as the treasury; mining operations and manufacture; commerce; forest produce; tolls; weaving; agriculture; livestock; armoury; intantry; chariots; etc. etc. Specific duties are in fact described for no less than 25 different Superintendents by designation.

Ain-i Akbari : circa 1590 A.D.

8. In another peak period of Indian history, in the time of the great Akbar, we find a description of a highly developed statistical system in *Ain-i Akbari* which is practically the administration report and statistical returns of his government as it was in 1590 A.D. In the introduction to the second volume, H. S. Jarrett observed:[3]

> "It will deservedly go down to posterity as a unique compilation of the systems of administration and control through the various departments of Government in a great empire, faithfully and minutely recorded in their smallest detail, with such an array of facts illustrative of its extent, resources, condition, population, industry and wealth as the abundant material supplied from official sources could furnish."

9. The approach is definitely scientific. For example, the author discusses various standards for the measurement of length, and describes how Akbar "seeing that the variety of measures was a source of inconvenience to his subjects, and regarding it as subservient only to the dishonest, abolished them all," and brought the *Ilahi gaz* in general use (Vol. II, *Ain* VIII, pp. 58-61). In the same way standards are developed for the measurement of land. It is noted that "a measure of hempen rope twisted which became shorter or larger according to the dryness or moisture of the atmosphere" (pp. 61-62). Therefore, "the *jarib* was made of bamboos joined by iron rings. Thus it is subject to no variation, and the relief to the public was felt everywhere while the hand of dishonest greed was shortened." (*Ain* IX, pp. 61-62). Other measures of area and volume as well as the standardisation of currency receive minute attention.[4]

10. In *Ain* XI (pp. 62-63) a detailed account is given of the classification of land based on the yield of crops. A distinction is made between yields in the two seasons 'spring harvest,' and 'autumn harvest.' Furthermore, yields are given for three different grades of soil, "best, middling, and worst;" and the average of the three grades is calculated as "the medium

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[3] English translation by H. Blochmann (Vol. I, 1873) and H. S. Jarrett (Vol. II, Vol. III, 1894) published by the Asiatic Society of Bengal: Vol. II, p. vii.

[4] *Ain-i Akbari* gives the area, revenue valuation, strength of army, and other details for about 15 *subahs* (provinces) comprising over 130 *sarkars* (districts) and over 3000 *mahals* (townships and sub-divisions) extending from Assam and Arakan to Afganistan; the average yield of 31 crops for 3 different classes of land; annual records of rates based on the yield and price of 50 crops in 7 *subahs* (provinces) extending over 19 years (1560-61 to 1578-79 A.D.); daily wages of men employed in the army and the navy; labourers of all kinds; workers in stables, etc.; average prices of 44 kinds of grains and cereals, 38 vegetables, 21 meats and games, 8 milk produces, oils, and sugars, 16 spices, 34 pickles, 92 fruits, 34 perfumes, 24 brocades, 39 silk, 30 cotton cloths, 26 woollen stuffs, 77 weapons and accessories, 12 falcons, elephants, horses, camels, bulls and cows, deer, precious stones, 30 building materials; weights of 72 kinds of wood, etc.

It is no wonder that speaking of Abul Fazl, Jarrett has remarked (II, p. v), that "regarded as a statistician, no details from the revenues of a province to the cost of a pine-apple, from the organisation of an army and the grades and duties of nobility to the shape of a candlestick and the price of curry-comb, are beyond his microscopic and patient investigation."

product of a *bigha.*" For the spring harvest, figures are given for from 10 to 20 crops; and for the autumn harvest, for 20 or 30 crops.[5]

SURVEY OF EASTERN INDIA: 1807-1815 A.D.

11. In the first decade of the 19th century, when the British regime in India was rapidly expanding and growing in strength, a comprehensive survey of Eastern India was undertaken by Dr. Francis Buchanan under orders of the Board of Directors of the Hon'ble East India Company dated 7th January 1807. The terms of reference cover an amazingly wide ground as can be seen from the extracts reproduced in Appendix (1). The Survey was pursued by Dr. Francis Buchanan for 7 years when only a portion of the territories under the Government of Bengal Presidency was investigated. The material was sent to London in 1816, and Montgomery Martin published in 1838, a selection in three volumes comprising over 2400 closely printed pages.

12. The book still makes fascinating reading. To whet your curiosity, I shall describe some of the items collected about the people of Patna city and the surrounding region. Information is given, for example, about the number and proportion of families in different consumption levels such as, families that use milk daily; that use milk in the chief season; that use milk on holidays; that use milk seldom. In the same way, information is given by categories of families according to the use of different kinds of dress, bed-sheets, blankets; the consumption of meat, fish, milk, vegetables, spices, oil, salt, rice, wheat, sweetmeats etc; different kinds of fuel and oil; different types of conveyance; state of education ; etc.

13. The utilization of land is shown by giving the areas separately for a large number of categories such as houses, trees, kitchen gardens, vegetables, etc. As regards agriculture, separate acreage figures are given for the area under 200 different combinations of crops, single and mixed. A general table is given for the value of the produce in the case of commercial crops; and both quantity and value in the case of cereals and food crops together with estimates of the marketable surplus; and number of livestock under different categories together with the annual production of milk with prices.

14. There are tables showing the proportion of rent paid by different sections of the population; the economic position of farmers with proportion of indebted families; and the number of artisans classified into 108 different categories. The manufacture of cotton cloth receives special attention; and detailed estimates are given of the number of weavers; looms; monthly production; earnings and profit for different kinds of cloth. Finally, there are tables of exports and imports (for the region surrounding Patna

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[5] One interesting practice deserves notice. The ten *ser* tax (*Dahseri*) is thus described: "His Majesty takes from each *bigha* of tilled land ten *sers* of grain as a royalty. Store houses have been constructed in every district. They supply the animals belonging to the State with food, which is never bought in the bazars. These stores prove at the same time of great use for the people ; for poor cultivators may receive grain for sowing purposes, or people may buy cheap grain at the time of famines. .... They are also used for benevolent purposes; for His Majesty has established in His empire many houses for the poor where indigent people may get something to eat." (Vol. I, 1927, p. 285).

The optional payment of revenue in the form of grain may deserve serious consideration as an alternative method of grain procurement in these days of food rationing in India.

city) in which separate figures are given for 140 different categories of commodities.

15. The report everywhere shows the critical attitude, keen scientific spirit, and the experimental approach of Dr. Buchanan. The wealth and reliability of the information (as far as this can be judged from internal evidence) make this report one of the most remarkable surveys of all times. There is nothing in any subsequent survey in India to approach the one conducted by Buchanan 140 years ago.

16. It is not entirely fortuitous that the three surveys mentioned above were associated with three great periods of political and socio-economic expansion in India. The statistical system is a visible mark of the political framework of each country. The statistical organization, therefore, inevitably follows the rise and fall of the wider administrative system. I shall examine later the position of statistics in the changing conditions of India at the present time.

DEVELOPMENTS IN OTHER COUNTRIES

17. The practice of descriptive statistics gradually developed, with ups and downs, in all countries of the world. Aristotle's work contained references to information about no less than 158 states.[6] Besides public administration, statistics was in much use in commerce. Certain forms of commercial insurance existed in Babylonia, Greece and Rome, and in the middle ages in Italy. By the end of the 18th century, life insurance was becoming prevalent in Western Europe. All this led to important statistical studies. In 1662, for example, John Graunt used the register of deaths (Bills of Mortality) in London to investigate population trends. Since then, in Europe, the study of statistics has been closely associated with actuarial science. On the break-up of the feudal system, the expanding national economies required increasing use of factual information for the formulation of financial, military and political policies. This process has continued down to the present times. In fact, the need of fighting a total war led to an unprecedented expansion in statistical activities in the last ten years to which I shall again refer.

GAMES OF CHANCE AND PROBABILITY

18. I must now turn to the analytic side of statistics. Curiously enough, the first phase of development occurred in connexion with games of chance, particularly the theory of the equitable division of stakes for which early solutions were given by Cardan and Galileo in the 16th century. A little later, Pascal and Fermat developed more general methods on the basis of permutations and combinations. In this way the concept of probability, based on chance, gradually became the subject of much mathematical investigations culminating in the work of Laplace in early 19th century.

THE TOSSING OF A COIN

19. The concepts were fundamentally new and deserve consideration. A simple example is the tossing of a coin (which is assumed to have no bias in favour of turning up either heads or tails). At each throw, it is completely

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[6] H. Westergaard, *Contributions to the History of Statistics*, 1932, [illegible]

uncertain whether the coin will turn up heads or tails. And yet, if the coin is thrown a large number of times (or, alternatively, if a large number of coins is thrown at the same time), it is practically (but never absolutely) certain that heads and tails would turn up approximately in equal numbers. The larger the number of throws (or the number of coins thrown at the same time), the greater is the chance of heads and tails being equal in frequency. Starting from a situation which is entirely indeterminate and uncertain, it is thus possible to reach conclusions with considerable (but never complete) certainty.

20. Several points require to be emphasized. First, it is quite impossible to predict anything about a single toss of a single coin; the prediction (of roughly equal frequency of heads and tails) refers to one whole set of throws. That is, prediction belongs not to any individual throw but to a group or assemblage of throws as a whole. Secondly, the existence of fluctuations or variations is inherent in the very nature of the situation. The relative frequency (that is, the proportion of heads and tails) will never remain exactly equal, but will inevitably fluctuate from one throw to another. Thirdly, because of the existence of fluctuations or variations, it is never possible to make any absolutely certain prediction. For example, however large the number of throws, the coin may turn up heads (or tails) all the time. In principle, even if the coin is tossed a million or a billion (or a larger number of) times, in the very long run, sometimes the coin should (and must) turn up heads (or tails) on the million or billion (or all) occasions.[7] In other words, the prediction is essentially a prognosis which is likely to hold only "in the long run". Fourthly, and this is a very important point, although the prediction is never absolutely certain, it is possible to estimate the limits of uncertainty.

21. The proportion of heads and tails in the tossing of a coin is thus recognized as a statistical variate which is intrinsically subject to variations or fluctuations. The proportion of male and female births is exactly analogous to the proportions of heads and tails in the tossing of a coin. Before birth, nothing is known about the sex of the individual child, and yet the prediction of a roughly equal frequency of the two sexes can be made with practically the same confidence as the equal frequency of heads and tails.[8] Any inference about the results or any prediction is, therefore, necessarily uncertain; but the margin of uncertainty is itself capable of estimation.

THEORY OF "ERRORS" OF OBSERVATION

22. The position is similar in the case of physical observations. However careful the observer may be, even the simple measurements of the length of a rod have been always found to vary. The average of a number of repeated measurements, however, usually becomes more and more steady as the number of measurements increases. The deviation from the average, *i.e.*, the "error" of each individual measurement is sometimes positive and sometimes negative, and thus behaves like heads and tails in the tossing of a coin. In the 18th century the new concepts of probability began to be applied to the adjustment of astronomical observa-

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[7] This is, of course, very very unlikely to happen which merely means that the probability is extremely small but, in principle, not zero.

[8] Laplace discussed in a memoir of 1781 the number of male and female births in Paris for 26 years (251, 527 males and 241, 951 females) from the point of view of probability. (*Histoire de l'Academie* for 1778).

tions and physical measurements which led to the growth of the theory of errors culminating in the work of Gauss and Laplace.

INDIVIDUAL VARIATIONS AND FLUCTUATIONS

23. If the height of a number of individuals is measured, these measurements again vary. This is equally true for every kind of measurement in biology. Fluctuations or variations are thus intrinsic features of all measurements. In biology, variation itself supplies the material for evolution. Variation is also the outstanding feature in all social sciences.

MEASUREMENTS AND OBSERVATIONS IN SCIENCE

24. A crucial point in the argument has been now reached. All contingent knowledge is based on measurements and observations. Lord Kelvin remarked long ago:

> "When you can measure what you are speaking about and express it in numbers, you know something about it, but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind." [9]

Secondly, every set of measurements (in every field of science—physical, biological and social) is characterized by variation. The aim must therefore be to draw general conclusions from a particular set of measurements, taking variation itself into consideration and not ignoring it.

THE CONCEPT OF RANDOM SAMPLES

25. This is exactly the aim of the theory of estimation and statistical inference. Each set of measurements (with its characteristic variation) is recognized to be only one out of many possible similar sets. Secondly, the totality of all possible sets of measurements (that is, the totality of all possible samples) constitute the "population" or "universe" in which we are interested. In order to reach conclusions about the population or universe, it is clearly necessary that a sample should be representative of the universe. The condition for such representativeness is supplied by the fundamental concept of "randomness." I do not think it is possible to define randomness, but some indication may be given as to its implications. Suppose it is desired to find the average height of a particular group of people. Obviously, it will not do to select individuals who are very tall or very short (or have any other special feature) as the results are likely to get biased. The only safe course is to choose the sample without reference to any previous knowledge about the individuals included in the sample. A random procedure ensures such selection free from bias. Once a random sample is available, it is possible to use the calculus of probability in a valid way to reach general conclusions about the statistical population or universe from which the sample was drawn. The concept of random samples is thus pivotal in statistical theory.

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[9] It is interesting to note that exactly the same idea occurs in the original meaning of the word *sankhyā* (literally, number) in Indian thought. The phrase *sankhyātā* occurs in the *Atharva-Veda* in the sense of "well-known." For more than three or four thousand years in India an intimate connexion has existed between the concepts of "number" and "adequate knowledge." This is why I chose *Sankhyā* as the name of the Indian Journal of Statistics. Further references are given in Appendix (2).

UNCERTAIN INFERENCE

26. Knowledge based on a statistical or random sample is however necessarily incomplete, as it relates to only one out of many possible samples. Conclusions based on a random sample, although valid, must therefore, be necessarily uncertain. It is however the great merit of the calculus of probability that although statistical inference is uncertain, it is possible to estimate a valid measure of the degree of uncertainty. In practice this is usually secured by stating the chance or odds in favour of any particular inference or result being "true" (in the sense of the prediction agreeing with subsequent observations). Suppose extensive agricultural trials have been made to compare the yield of two varieties of wheat. On available evidence, it is then possible to state the conclusion in some such form that the odds are 100 to 1 (or 1000 to 1, or some other odds) that variety A would give a higher yield than variety B. The very form of the statement indicates that, "in the long run", 99 times out of 100, variety A would give a higher yield. Necessa ily, therefore once in 100 trials (not in every 100 trials, but again, "in the long run") variety A would give a lower yield. This lower yield may, however, occur in the very first trial. The risk is always there. Not only this, occasionally (or once in 100 trials "in the long run") the prediction must prove wrong. If it did not, then the whole basis on which the prediction was made would itself prove to be wrong. In statistical inference, we thus reach the fundamental paradox:

If statistical theory is right, predictions must sometimes come out wrong; on the other hand, if predictions are always right, then the statistical theory must be wrong.

DEDUCTIVE LOGIC AND MATHEMATICS

27. There is a sharp contrast between statistical or uncertain inference and absolutely certain deductive conclusions. It is a significant fact that the concept of probability developed very late in the history of human thought, as far I know, only during the last two or three hundred years. Deductive logic, on the other hand, is very old. Absolute certainty in fact has long been accepted as the essential characteristic of true knowledge. Pure mathematics is the great historic example. In pure mathematics the conclusions follow inevitably from the premises, and all inferences are absolutely certain. This is why Bertrand Russel described pure mathematics as the class of all proposition of the form: "P implies Q". Deductive logic, therefore, includes the whole of pure mathematics.

DETERMINISTIC VIEWS IN PHYSICAL SCIENCES

28. An invariable sequence of cause and effect is in many ways similar to the formal-deductive process in logic and pure mathematics. In the physical sciences, with the help of the causal principle, the rigour of absolute certainty of mathematical reasoning was accepted for a long time as the ideal model. Newton in writing his great treatise on the principles of natural philosophy deliberately adopted the mathematical form. The possibility of constructing a rational model of the whole universe was a great triumph of the human mind. The growing complexity within the natural, and later in the biological and social sciences, however, led to the gradual replacement of the deterministic-mathematical model by the probabilistic-statistical view. This change was brought about not by abstract reasoning but by the force of events within the field of science itself.

THE ENTROPY PRINCIPLE

29. The Newtonian equations of motion become increasingly unmanageable with the increase in the number of particles requiring to be taken into consideration. It soon became necessary to study the properties of a system comprising a large number of particles. The object now was not to ascertain the motion of each single particle separately, but to investigate the collective properties of all the particles taken together. Concepts and results already available in the theory of errors of observation were pressed into service to develop the kinetic theory of gases. A parallel development of the subject of thermodynamics led to the emergence of the entropy principle. The central concept in the second principle of thermodynamics is again randomness, so that the principle of the increase of entropy is recognized as nothing but the increasing degree of randomness of the physical universe.

THE UNCERTAINTY PRINCIPLE IN PHYSICS

30. A further shift to a statistical model occurred with the development of statistical mechanics culminating in the enunciation of the uncertainty principle by Heisenberg which denied the possibility of absolutely certain knowledge of both the position and the motion of a particle at any given instant. From a theoretical point of view, the uncertainty principle would seem to make physical science essentially statistical in nature. The belief that complete certitude is an essential condition for genuine knowledge, however, still persists in certain quarters. The uncertainty principle is looked upon as belonging to the region of the very small, and therefore not inconsistent with the deterministic view of the world as a whole.

31. I doubt whether the above view is tenable. If science is based on observation and measurement and if each set of measurements is a statistical sample, then all scientific conclusions must be of the nature of uncertain inference (with, in principle, a known margin of uncertainty). The contrast can be clearly seen in the distinction between a mathematical constant and a statistical or physical quantity based on observations. The ratio of the circumference to the diameter of a circle is a mathematical abstraction and, therefore, not subject to any fluctuations. All physical quantities, on the other hand, are based on observation and measurement, and are therefore statistical estimates, necessarily subject to a margin of uncertainty. On this view, all scientific predictions must be characterized, in principle, by a margin of uncertainty.

INDUCTIVE LOGIC

32. It may be observed at this stage that J. S. Mills' empiricism is a departure from rationalism only in form in as much as the aim of Mills' inductive logic still remains "certain" inference. Similar attempts were made much earlier in India to go beyond the purely formal-deductive process. Sir Brajendranath Seal has given an interesting account of the doctrine of inference in the *Positive Sciences of Ancient Hindus* (1915), from which certain extracts have been given in Appendix (3). All these attempts, however, had certitude as the aim of inference. But in Indian thought, it was recognized, in one sense, that this aim is unattainable in practice. B. N. Seal noted for example:

> "Ultimately we all have to fall back on the rational practice of thinking persons, and such persons are always content to act on practical certitude instead of hankering after an unattainable apodectic certainty

> in the affairs of life. This same practical certitude is also the ultimate warrant of the Deductive-Inductive Inference by which we ascertain the characters of things without direct perception and through the medium or instrumentality of a mark."[10]

FALLIBILITY OF SCIENTIFIC KNOWLEDGE

33. I have been trying to place before you the view that all scientific knowledge (being based upon evidence which is formally incomplete) is only probable and never absolutely certain. All predictions based on scientific knowledge must, therefore, be fallible ; and must in fact prove wrong, in the long run, to the anticipated extent. Ernest Nagel observes that those

> "who maintain that our knowledge of matters of fact is "probable" do not thereby maintain that such knowledge is inferior to knowledge of some other kind obtainable by methods different from those the natural sciences employ. On the contrary, they maintain that "probable knowledge" is the only kind of knowledge we can find or exhibit, and that the methods and techniques of the sciences are efficacious and dependable precisely because they make available knowledge of that character."[11]

Thus in the whole field of science, the deductive-mathematical process of absolutely certain inference is being replaced by the probabilistic-statistical method of uncertain inference. Ernest Nagel has stated the position very clearly:

> "The long history of science and philosophy is in large measure the history of the progressive emancipation of men's minds from the theory of self-evident truths and from the postulate of complete certainty as the mark of scientific knowledge."[11]

DETERMINISM AND UNCERTAINTY

34. If the probabilistic model is accepted as a closer approach to reality, then interesting consequences are likely to follow in the field of human thought and philosophy. I have no competence to discuss such issues, but one or two observations may not be entirely out of place. All knowledge based on science, and hence all scientific predictions about the future must be recognized, in principle, as uncertain. It is possible however to admit, in principle, that knowledge about the past may be of a deterministic type. The uncertainty about the future may then be interpreted as supplying an opportunity for fresh creation (at least, as perceived by the human mind). In fact, the 'present moment' on this view is the actual occasion of an ever-continuing stream of creation which is marked in rational thought by the transition from a deductive-mathematical to a probabilistic-statistical model of reality.

STATISTICAL METHODS IN THE CONCRETE

35. I have so far considered the statistical method in the abstract. A brief survey of the scope and range of the statistical method in the concrete is also of interest. A convenient way of doing this is to construct a kind of mental map of scientific activities. We may start with a geometrical point at the centre to represent pure mathematics. On the view which

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[10] *The Positive Sciences of Ancient Hindus,* (Longmans, Green & Co., London). 1915, p. 269.

[11] *Principles of the Theory of Probability,* (University of Chicago, U.S.A.) 1939, pp. 3-4.

I have expounded, pure mathematics (being fundamentally deductive in nature) does not itself belong to the field of science; and can be, therefore, appropriately represented by a mathematical point which has "position but no dimension".

Physical Sciences

36. We may draw a small circle round the centre to represent classical physics in which although the form is still mathematical, actual knowledge is based on measurements subject to errors of observation. Fluctuations are, however, small in magnitude so that predictions can be made with great certainty (but are still, in principle, affected by a margin of statistical uncertainty.) A second larger circle may be drawn to represent the area of kinetic theory of gases, statistical mechanics, and thermodynamics. In this region, factors of variation are still amenable to a large degree of control so that the classical method of experimentation (isolating and studying one single factor at a time) is usually available.

Biometry

37. A third larger circle may be drawn to demarcate an area where the factors of variation are more complex and less liable to control. This broadly represents the field of biological variation. In 1900, Karl Pearson coined a new word "biometry" to indicate generally the methods particularly appropriate to this area. The fruitful concept of statistical correlation historically had its origin in this field.[12] In the field of biometry, the fluctuations and variations are themselves of great importance, and often supply convenient yard-sticks for purposes of measurements.

38. During the last 50 years, biometry has become a very large branch of statistical science. It covers practically the whole field of biology and genetics including agriculture and the study of livestock. Biometric methods are also being increasingly used in psychology, education, and the medical and social sciences including the study of the human factor in industry.

39. In dealing with living units, it is usually impossible to use the classical method of isolating and studying one single factor at a time. For example, in studying the increase in the yield of crops due to improved seeds or fertilizers or better methods of cultivation, fluctuations in the fertility of the soil from plot to plot, the influence of weather conditions, and many other factors of variation are always present and can not possibly be isolated. A radical departure had become necessary and took place, about a quarter of a century ago, in the development of the design of experiments and the analysis of variance under the leadership of R. A. Fisher[13]. He himself has observed:

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[12] In 1877 when Sir Francis Galton measured the size of sweet peas in his studies of heredity, he found a "regression" of the size of the daughter seed, compared to the size of the mother seed, towards the general mean. He found the same thing again in connexion with his observations on the height of fathers and sons. These studies led to the development of the theory of regression and correlation by Karl Pearson and others. It is worth noting that Gauss himself had used the product term in his investigations on the theory of errors, but had failed to reach the concept of correlation. The French astronomer Bravais (1811-63) worked on what is in essence the mathematics of correlation, as early as 1846. The concept of regression and correlation, however, did not emerge until 40 years later; and this also, only under the stimulus of the study of biological variations. This perhaps is a corroboration of the view that statistics is essentially an applied science and not a branch of mathematics.

[13] *The Design of Experiments* (Oliver and Boyd, Edinburgh. 1935; 4th Edition, 1947).

> "No aphorism is more frequently repeated in connexion with field trials than that we must ask Nature few questions, or, ideally, one question at a time. The writer is convinced that this view is wholly mistaken. Nature, he suggests, will best respond to a logical and carefully thought out questionnaire; indeed, if we ask her a single question, she will often refuse to answer until some other topic has been discussed."[14]

40. The central aim of the design of experiments is to make experimental observations in such a way that the different factors of variation would have scope to come into play in a balanced fashion so that it would be possible to study the influence of single factors as well as of various combinations of factors at the same time. In fact, R. A. Fisher has remarked: "The more thorough the design of the experiment, the more meaningful is the question asked." Actual experience has shown abundantly the great advantages (in economy of time and effort, and in adaptability) of using appropriate statistical designs in scientific and technological experiments of all kinds.

41. The fact of variation is as universal in the field of industrial production as in biology. Even with machines of the highest precision, no two units are identical in size or other specifications. Usually there is the additional complication of fluctuations in time, but such fluctuations themselves often supply convenient yard-sticks for diagnostic purposes. So long as the fluctuations remain stable, the system may be considered to be under statistical control. W. A. Shewhart[15] used this fundamental concept to develop 'control limits' and 'control charts' to enable the quality or output of manufactured products being maintained at a desired level. These methods found wide applicatons during the war. In fact, without the use of such methods, war production in the United States and other allied countries could never have been sufficiently stepped up. After the war, the use of statistical 'quality control' is steadily increasing all over the world, and a beginning has been made in a small way in India also.

STATISTICAL SAMPLING

42. We may add a fourth circle to demarcate the region in which the appropriate tool is statistical sampling. Factors of variation are now more complex and are usually not amenable to experimental control. This is the field where the traditional method of the exhaustive census or the attempted complete count has been used for a long time. R. A. Fisher has recently described the present position:

> "The words sample and sampling, like the word random, have always been central in the development of mathematical, or theoretical statistics. With the increased understanding and integration of our science they have now, as it were, overflowed from the world of abstractions in which they were generated and refined, and have, in fact, supplied the most adaptable, rapid, economical, and, in the true sense, scientific method of factual ascertainment which we yet possess.
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> "I have made four claims for the sampling procedure. About the first three, adaptability, speed and economy, I need say nothing further. Too many examples are already available to show how much the new

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[14] The Arrangement of Field Experiments, *Journal of the Ministry of Agriculture*, Vol. 33 (1926), p. 511.

[15] *The Economic Control of Quality of Manufactured Products*, (McMillan & Co., London, 1931) ; and *Statistical Methods from the View point of Quality Control.* (Graduate School, Department of Agriculture, Washington, D.C., 1939 ; reprinted 1945).

method has to give in these ways. But, why do I say that it is more scientific than the only procedure with which it may sometimes be in competition, the complete enumeration? The answer, in my view, lies in the primary process of designing and planning an enquiry by sampling. Rooted as it is in the mathematical theory of the errors of random sampling, the idea of precision is from the first in the forefront. The director of the survey plans from the first for a predetermined and known level of precision; it is a consideration of which he never loses sight; and the precision actually attained, subject to well understood precautions, is manifest from the results of the enquiry".[16]

Rapid developments in this field have taken place during the last ten or twelve years in which India has made significant contributions. I shall come back to this subject a little later as it is of great current interest in India.

FREE OBSERVATIONS

43. We may now add a fifth circle to indicate the area in which factors of variation are neither amenable to control, nor to experimentation, not even, in the usual sense of the term, to sample-surveys or sample-censuses. Here the only feasible approach is the patient collection of observations followed by classification and painstaking investigation of possible statistical relationships. Experimentation is no longer possible, but it is still feasible to compare predictions with subsequent observations. Statistical methods are particularly appropriate in this field. I shall give one example from my own experience.

44. In 1926 a catastrophic flood occurred in the Brahmani river in Orissa. An expert committee of engineers appointed by the Government of India reached the conclusion that the bed of the river had risen by several feet and consequently the flood level was likely to be higher in future. The Committee naturally recommended raising the height of the embankments by several feet to give protection against higher floods. At the request of the Government of Bihar and Orissa, I made a detailed statistical study, and found a significant correlation between the rainfall in the catchment area and the height of the river flood in the delta.[17] Using the statistical relationship, I found that the abnormal rise of the river in 1926 could be reasonably ascribed to exceptionally heavy rainfall in the catchment areas. On the basis of such statistical evidence, it was possible to advise Government that there was nothing wrong with the river, and it was *not* necessary to increase the height of the embankments. This advice was given in 1930. The fact that no great change has occurred in the severity or frequency of floods during the last 20 years shows that the statistical findings were correct. Direct experimentation in such cases is out of question ; the statistical method supplies the only valid tool for scientific investigation. Incidentally, in this case, it also saved several crores of rupees.

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[16] Presidential address on "The UN Sub-Commission on Statistical Sampling" at the session on Sampling, International Statistical Institute, Berne, September 1949.

[17] One technical point deserves notice. The catchment area was divided into two portions, and the rainfall in the two catchments were used as two separate variates for correlation with the height of the river flood. *Report on Rainfall and Floods in Orissa Rivers* (submitted in *1930*, and printed by the Government of Bihar and Orissa). The statistical studies made at this time supplied the basic information for the Hirakud Dam, one of the big river valley projects in India.

45. I should like to include in the mental map the field of operational research in which the available information is either too meagre, or is not in a suitable form for the calculation of the probability involved in the problem. In such cases a decision, however, has to be reached by balancing the risks of gain and loss but without the formal use of the probabillty calculus. Operational research thus comes within the general scope of the statistical method.[18]

STATISTICS IN EVERYDAY LIFE

46. The importance of statistics in the field of science is due to its supplying the general method for inductive inference. The growing importance of statistics in public estimation, on the other hand, is mainly due to its increasing practical applications in the affairs of everyday life. It is necessary to remember that at one time physical science itself was held in low esteem in the public eye, and was often a subject of contempt and ridicule. It is interesting to observe that Thomas Sprat made the following observations in 1667, five years after the foundation of the Royal Society of London:

> "It is not to be wonder'd at if men have not been very zealous about those studies, which have been so far removed from present benefit, and from the applause of men. For what should incite them to bestow their time, and Art, in revealing to mankind, those Mysteries; for which, it may be, they would be onely despis'd at last? How few must there needs be, who will be willing, to be impoverish'd for the common good? While they shall see, all the rewards, which might give life to their Industry, passing by them, and bestow'd on the deserts of easier studies?[19]

It is only with the great technological achievements of physical science that public opinion changed in a remarkable manner, and it rose in public esteem. It is this public esteem which enabled the physical scientists to secure sufficient leisure, support, and recognition to pursue their researches free from care and anxiety. This also led to the growth of the belief that scientific research is pure in the degree in which it is removed from practical applications.

'PURE' AND 'APPLIED' SCIENCE

47. I am prepared to admit that a distinction may perhaps be made between 'pure' and 'applied' science. A subject like physics, for example, has a clear responsibility for developing a picture of the universe in terms of physical concepts and elements even if this picture has no practical applications. This is also true of other 'pure' sciences like chemistry, botany, zoology or geology; each has the task of supplying a world-picture in its own terms. In an applied science like engineering, the position is quite different. It has no responsibility (nor any possibility) of giving a general theory of the world in terms of engineering. Its only task is to solve a practical problem. It must, of course, undertake research in its own field. As regards mathematics, it is simply not possible to have too much help from that subject, but there is no such thing as 'mathematical engineering'.

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[18] The work is, no doubt, closely connected with engineering or technological and scientific invetigations so that the position is somewhat similar to the field of statistical quality control.

[19] *History of the Royal Society*, London, 1667, p. 27.

STATISTICS—ESSENTIALLY AN APPLIED SCIENCE

48. In the same way, statistics is essentially an applied science. Its only justification lies in the help it can give in solving a problem. Its aim is to reach a decision, on a probabilistic basis, on available evidence. If the problem is one of a theoretical nature, statistics supplies a valid method for drawing general conclusions from particular experience. If the problem is a practical one, statistics supplies the basis for choosing a particular course of action (in preference to other possible courses) by balancing the risks of gain and loss. This is why Clark Maxwell once remarked that "the true logic for the world is the calculus of probability."

49. On the above view, we can not contemplate any cleavage between the thoery and the practice of statistics. On one side, statistics must necessarily be tied closely to practical ends. On the other, it must try at the same time to mke its technical apparatus more and more general, and hence more and more abstracted from particular applications. Statistics, like engineering, requires all the help it can receive from mathematics; but statistical theory can never become a branch of mathematics. Individual workers would specialize in particular fields in accordance with their own preference. Some would apply their mind closely to practical applications; some to the development of the mathematical technique; and others to the formulation of logical concepts and abstract theory. The number of persons working in the different fields would be naturally determined, partly by the demand for particular types of work (applications, or mathematical technique, or logical concepts and foundations) and partly by the supply of men of the required aptitude and ability. The integration of practical applications with mathematical and theoretical studies, which is the characteristic feature of modern statistics, is perhaps a good model for other sciences also. If technology is divorced from scientific research, it would soon loose its efficiency and adaptability to meet changing requirements. On the other hand, if research is cut off from the stimulus to solve vital problems of human society, it would become lost in sterile intellecutual acrobatics.

THE SOCIAL BACKGROUND OF STATISTICS

50. In statistical research the greatest stimulus has always come from the need of solving practical problems. R. A. Fisher's work on the design of experiments was due to the urgent need of solving the deadlock in agricultural field trials. W. A. Shewhart's work on quality control arose from the need of improving the efficiency of inspection in large scale production. On the organizational side also, statistical work is closely determined by the special needs of the country and by the socio-economic frame-work. Statistics is not only an applied science but is also a public science. It is because of the close connexion with public activities that big developments in statistics have always occurred only when there has been need of unified policy and co-ordinated action in times of war or peace. I shall give three examples.

51. For a long time the volume of statistical work has been greater in the United States than in any other country of the world. But it was only during the New Deal in the 1930's when unified governmental policy became indispensable in the economic field, that effective action was first taken for the central co-ordination of the statistical activities of the Federal Government. Other large developments took place because of the need of planning in war production; and it was only in 1942 that an Act

was passed to assign definite statutory responsibilities to the special Division of Statistical Standards in the executive office of the President of the United States.

52. In the United Kingdom also, under *laissez faire*, statistics had been developing in a more or less haphazard manner without any focal centre within the governmental machinery. All this, however, changed rapidly owing to the need of total planning during the war. A Central Statistical Organization was set up and was entrusted with the duty of reviewing and making a critical appreciation of all statistical information required by the Cabinet. Although the different Ministries have their own statistical divisions, there is complete co-ordination at the top. After the war, the importance of the Central Statistical Organization has continued to increase with the growth of social and economic planning in the United Kingdom.

53. In the U.S.S.R., developments in the statistical field have gone much further. From the beginning a Central Statistical Bureau has been an integral part of the GOSPLAN. No plan can be put into operation until it is cleared by the Statistical Bureau. The Bureau not only helps in preparing the different plans, but also submits reports on the progress of such plans on the basis of the information collected directly by the Bureau. In 1947 it had in fact a staff of 22,000 scattered all over Russia and paid and controlled directly by the Bureau. Central control by statistical methods is thus complete in the U.S.S.R.[20]

54. In India also there was a great deal of expansion in statistical work during the war without, however, any central co-ordination. Such lack of co-ordination was inevitable in the absence of any coherent over-all economic policy. Until the Government of the country has an urgent sense of the need of statistical services in shaping policy and programme of action, little progress is possible. In spite of much talk, no action was taken for central co-ordination in India until very recently. There was indifference and even hostility to new ideas and new developments. This is typical of the struggle through which scientific innovations must pass in order to establish their worth. I may illustrate these points by briefly recapitulating the story of sample-surveys in India.

SAMPLE-SURVEYS IN BENGAL

55. For a long time, crop statistics was known to be unreliable in Bengal. In 1934 I discussed with Mr. H. P. V. Townend, I.C.S., (then Development Commissioner, Bengal) the possibility of using random samples for the improvement of the Jute forecast. On his initiative, a sample-survey on an area basis was conducted over the whole province in 1935. I believe this was the first area-sample in the whole world.[21] The results were not satisfactory; chiefly, I thought, because of defective field work. A little

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[20] It is interesting to note that about a year ago, the Central Statistical Bureau was removed from the GOSPLAN and was placed directly under the Council of Ministers (which corresponds to the Cabinet in India). This would seem to indicate that the Bureau now has the further responsibility of submitting reports on the GOSPLAN itself.

[21] As far as I know, Sir John Hubback was the first person to consider random sampling for estimating crop areas; but he did not use it in practice. His own work was concentrated on statistical sampling for the yield of rice in Bihar and Orissa in the early 1920's. His original report "Sampling for Rice Yield in Bihar and Orissa" published in 1927 as Bulletin No. 166 by the Agricultural Research Institute, Pusa, was reprinted it *Sankhyā*: the Indian Journal of Statistics, Vol. 7, Pt. 3.

later, the Indian Central Jute Committee approved a five-year scheme for a sampling method for the jute crop. Work was started, on a very small scale, in 1937, and an efficient sampling plan was developed by the Indian Statistical Institute by a series of annual surveys, on a gradually expanding scale, until the whole province was covered in 1941.

56. Three tests had been laid down for the sampling plan which were adequately fulfilled. The method was speedy, inexpensive, and the margin of uncertainty of the provincial estimate was only about 2 per cent[22]. Influential opinion was, however, still strongly opposed to the scheme, and it was terminated at the end of 1941. Since then it has passed through many vicissitudes. The sample-survey was revived in 1942 for only one year. Since 1939 I had been pressing Government to have the sampling plan extended to rice. In view of the cessation of the supply of rice from Burma, which by this time had fallen to the Japanese, I sent to a high agricultural official in New Delhi in March 1942 a plan for a sample survey of rice in Bengal; my letter was not acknowledged. In 1943 a famine broke out in Bengal and caused the death of a million-and-a-quarter or a million-and-a-half of men, women, and children. The sample-survey was started afresh in April 1943; was stopped after two months, in June; and was again started in August and extended to the rice crop for the first time, owing chiefly to the urgent need of food statistics.

57. The adequacy and reliability of the sample-survey was challenged on every occasion. In fact, a sample-survey of crops which had been started in Bihar in 1943-44 was discontinued after one year on the advice of the Agriculture Department of the Government of India, in spite of my earnest pleadings in personal discussions, and in a letter which I sent to New Delhi on the 23rd March 1945. In Bengal also, the position was precarious in 1944. However, after many debates and discussions, the Government of Bengal decided to continue the sample survey, and also to organize a plot-to-plot enumeration with a view to comparing the two methods.

Comparison of Sample Survey and Plot-to-plot Enumeration in Bengal : 1944-45

58. In accordance with the above decision, a plot-to-plot enumeration was conducted directly by the Government of Bengal in the winter (*aman*) rice season of 1944 and the jute season of 1945; while the sample survey was conducted by the Indian Statistical Institute. The sample survey was, of course, much more economical. The total cost of the plot-to-plot enumeration was about Rs. 82 lakhs (about £61,500 sterling) while the cost of the sample survey was Rs. 8 lakhs only, or just one-tenth. The intensity of sampling was unusually heavy, owing to the desire of Government to have separate figures for 28 smaller geographical units (districts). For a provincial total, or for 3 or 4 regional breakdowns, the cost of the sample survey could have been easily reduced to Rs. 6 lakhs or even Rs. 4 lakhs. From the experience of about 12 years of work in Bengal, we have found that a sample-survey of crops can supply results of sufficient accuracy

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[22] A full account of the work up to 1941 was given in the paper "On Large Scale Sample Surveys", *Phil. Trans. Royal Society of London*, Vol. B. 231, (1944), 329–451; some later work has been described in "Recent Experimets in Statistical Sampling in the Indian Statistical Institute". *Jour. Royal Statistical Society*, CIX (4), 1946, 325–378.

for most practical purposes at a cost of only a fifteenth or a twentieth of that of a complete count.

59. It is, however, in the matter of precision that the sample survey has the greatest advantage. It is possible to make a direct comparison for the jute crop of 1945 in Bengal. Jute being primarily a cash crop, accurate export and trade figures become available about 15 months after the harvesting season. The sample-survey estimate, submitted to Government in September 1945, was 7,540 bales of jute.[23] The official forecast in the same month, based on the plot-to-plot enumeration, was 6,304 bales. According to the customs and trade figures which became available in January 1947, the Bengal production was 7,562 bales. The plot-to-plot enumeration gave an under-estimation of 16.6 per cent, while the sample-survey figure differed by only 0.3 per cent from the estimate based on trade figures. Details of the comparison are given in Appendix (4). *The plot-to-plot enumeration was ten times more expensive, and yet gave entirely inaccurate results.*

60. The reason for the greater reliability of the sample-survey is clear. The total staff employed in the plot-to-plot enumeration was about 33,000 against roughly about 600 or 700 in the sample-survey. Sample-surveys require a much smaller staff. It is, therefore, always possible to employ better trained people on higher pay, and also to maintain close supervision on their work. In consequence, the primary material in sample-surveys is usually of much better quality, and furnish final estimates of greater accuracy.

61. In Bengal, the superiority of the sample-survey was finally acknowledged in January 1948, when the sample-estimates were ordered by the Government of the Province to be accepted in future as official crop-estimates. It had taken eleven years (since 1937) to achieve this result.

62. A good deal of similar evidence has accumulated in other countries of the world. I shall refer to some very recent work in Japan. At the request of the Occupation Authority, the Japanese Government conducted in 1948 a plot-to-plot enumeration of crops (on the basis of old cadastral survey records) of the whole country. Sample-surveys were superposed to assess the accuracy of the plot-to-plot enumeration. The sampling work was done with great care, in fact, with plane table operations with the help of surveying instruments. The combined under-estimation (due to both non-reporting of fields, and under-statement of crop area reported) was about 9.5 per cent for paddy rice, 20 per cent for mixed cereals, more than 26 per cent for sweet potatoes and fully 35 per cent for upland rice.[24]

RECENT CHANGES IN ATTITUDE

63. In recent years the sampling method has won increasing recognition all over the world. In 1947 the United Nations established a Sub-Commission on Statistical Sampling which has already met three times in 1947, 1948 and 1949, and has issued three reports covering a very wide field. In India also there has been a distinct change of attitude. The

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[23] 1 bale = 400 lbs. of jute.

[24] United Nations document E/CN.3/Sub.1/17. Appendix C, pp. 27-32; and also an article on the "Incompleteness in a Census of Crop Areas in Japan" by Charles F. Sarle in *Agricultural Economics Research*, April 1949 (published by the United States Department of Agriculture).

Government of India are seriously considering the possibility of using sampling methods in the field of agricultural statistics. This has been brought about partly no doubt by the increasing prestige of the method outside India. But it is also symptomatic of a deeper change. The Government of India are giving increasing attention to the all round improvement of the statistical services of the country. This in its turn is due to a growing awareness of the urgent need of unified economic policy and action on the part of Government. It is the urge of solving vital national problems which is giving real strength to the progress of statistics in India. I shall now turn to some of these problems.

THE FOOD CRISIS IN INDIA

64. The biggest single problem in India at present is the shortage of food supply. On the 28th November 1949, Jawaharlal Nehru, the Prime Minister of India, is reported to have declared "I desire to make it perfectly clear that whatever happens, whether there is a cyclone or an earthquake, we are determined to stick to the target date of 1951, after which we shall not import food grains for our consumption." He stated that this decision had been forced on the country by the pressure of events, for no country could continue to live beyond its means which of course meant its production in its fields or its factories.

65. I shall try to give a statistical commentary on the Prime Minister's statement. This will serve two purposes. It will show how statistics comes into the picture, and how statistics can help in solving the problem. It will also show how inadequate is the available statistical information, and how much it requires to be improved. The figures quoted by me are, therefore, necessarily illustrative.

INCREASING PRESSURE OF POPULATION

66. The food position can be judged only in relation to population and other resources of the country. We know the total geographical area of the Indian Union. It is about 1.22 million sq. miles or 780 million acres.[25] As regards the population, the last decennial census was taken in February 1941. Since then conditions have been abnormal owing to war, the famine in Bengal in 1943, and the partition in August 1947 with subsequent large shifts of population. On the available information, the total population at present would seem to be something between 34 and 35 crores (340 and 350 millions).

67. The density of population is thus very high, something like 290 per square mile, which is bigger than the density in most countries of the world with the exception of the highly industrialized countries in Western Europe, and Japan. If we consider the individual share, in India we have only about 2.25 acres per head.[26] In comparison, China presumably has about 6 acres, the United States about 13 acres, and the U.S.S.R. nearly 28 acres for each individual. The pressure on land is many times greater in India compared to other countries with a large population.

68. The population is also increasing at a rapid rate. Between 1931 and 1941 the rate of increase was about 1.4 per cent for the

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[25] 3.159 million sq. kilometers.

[26] The total area under cultivation in India is not known accurately. It is probably something like 35 or 40 per cent of the whole area. The share of cultivated land is thus well below one acre per head.

Indian Union.[27] If this rate is being maintained, the population of India is increasing at present by nearly five millions every year. This is more than the total population in each of about 24 or 25 member States of the United Nations. Owing to the adverse conditions created by the war and the partition of India, the rate of growth may have slowed down. If it is only 1 per cent, the increase is still something like 3.5 millions per year.[28]

INADEQUACY OF FOOD STATISTICS

69. About population we have some information. The position is much worse about food statistics. In one province, West Bengal (covering only about 2.5 per cent of the total area of India), statistical sampling is being used and can be depended upon to supply estimates of the production of rice with a margin of uncertainty of about 2 per cent. For roughly half the total area of India, reports are available from *patwaries* (village revenue staff) or *chowkidars* (village watchmen) but nothing is known about their accuracy as no objective checks have been made. In roughly one-fifth of the whole area, reports are received from the State authorities, but nothing is known about the primary agency. No reports whatsoever are available about the food production for the remaining 30 per cent of Indian Union, and a conventional figure is written down every year in New Delhi. In spite of the Grow More Food campaign conducted for several years, according to official estimates of the Ministry of Agriculture, apparently no appreciable increase has occurred in the production of food. It is best to confess that we do not know the real position.

CRITICAL BALANCE BETWEEN FOOD AND POPULATION

70. There is some indirect evidence. Actuarial estimates on the basis of the decennial censuses between 1881 and 1931[29] show that there has not been any appreciable increase in the expectation of life at birth which hovered round or below 25 years during this period. This suggests that, although population increased at a rapid rate, there was no over-all improvement of the vitality of the people.

71. The famine in Bengal in 1943 was also an ominous indication. From the information collected by the Indian Statistical Institute in the course of a sample survey of famine conditions, I believe the total number of deaths was something between one-and-a-quarter and one-and-a-half million. The total loss (killed and missing) in the second world war was about 330,000 for the U.S.A., and 300,000 for the United Kingdom.[30] Thus the famine casualty in Bengal was double or more than double of the total war casualty for the U.S.A. and the U.K. taken together. It may be noted that in 1943, the area of the undivided province of Bengal was about 78,000 sq. miles, and the estimated population about 63 millions. The density was thus of the order of 800 per sq. mile, which was higher than

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[27] *Census of India Paper No.* 2, p. 6 (Government of India). The rate of growth during the same period in undivided India was 1.5 per cent per year.

[28] During the 40 years between 1901-1941, the average rate of increase was about 1 per cent per year in undivided India and over 0.8 per cent per year in the Indian Union. Even at this lower rate, the increase would be about 3 millions per year.

[29] No information is available for the 1941 census, as age-tables were not prepared. These are, however, now being constructed in the Indian Statistical Institute on the basis of the 2 per cent Y-sample.

[30] *Encyclopaedia Britannica: Book of the Year*, 1946, p. 846.

that in even the most highly industrialized countries of the world. The terrible pressure of population was no doubt a predisposing factor in the famine[31].

Increasing Food Imports

72. Some further indirect information is available from export and import statistics. Before the separation in 1937, Burma provided an abundant supply of rice. During the first two or three years of the war, the net import was negligible as the following figures will show.

Net Import of Cereals per Person

financial year	extrapolated population in millions	net import of cereals in million tons	import in lbs per year per person
(1)	(2)	(3)	(4)
1941–42	390.3	0.43	+ 2.5
1942–43	395.4	−0.29	− 1.6
1943–44	400.4	0.33	+ 1.8
1944–45	405.5	0.73	+ 4.0
1945–46	410.6	0.93	+ 5.1
1946–47	415.7	2.42	+12.9
1947–48	335.2	2.18	+14.6
1948–49	337.9	2.78	+18.4

(1) Population figures for undivided India were calculated by linear extrapolation with the observed growth rate between 1931 and 1941. Figures after partition (15 August 1947) are based on the *Census of India, Paper No. 2.*

(2) Up to 1942-43, net imports in col. (3) are taken from the *Food Statistics of India* (1946) published by the Food Department; from 1943-44, the figures are taken from *Indian Food Statistics* (August 1949) published by the Ministry of Agriculture. Since 1943-44 the figures relate to rice, wheat, maize, millet, barley and wheat flour, with a few minor variations.

73. In 1943-44, the year of the Bengal famine and the first year of introduction of food rationing, the net import was quite small and only about 1.8 lbs. per head per year. During the last five or six years, the position has grown steadily worse. The net import rose to about 18 lbs. per head in 1948-49, and the expenditure incurred was something like Rs. 120 or 130 crores (about £100 million sterling). The significance of this figure can be appreciated when it is recalled that the total revenue budget of the Government of India in 1949-50 is of the order of Rs.320 crores (£240 million sterling).

74. Another aspect of the problem is even more serious. If the food production and the home consumption remain constant, then the surplus coming to the market would also remain constant. In this situation, the total import should increase in proportion to the growth of population. In actual fact the import rose from 0.33 million tons in 1943-44 to 2.78 million tons in 1948-49. The was, no doubt, partly due to the cessation of supplies from Pakistan which was a surplus area. In any case, the supply coming into the market (through procurement or otherwise) has been steadily decreasing. This is the most alarming feature of the present situation.

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[31] "A Sample-Survey of After-Effects of the Bengal Famine of 1943". *Sankhya: The Indian Joural of Statistics.* Vol. 7 (4), 1946. pp. 337-400.

STATISTICAL BASIS OF A RATIONAL FOOD POLICY

75. What is the solution? There is obviously no single remedy. The problem has to be attacked on many fronts, and statistics can help on all fronts. I shall briefly try to indicate the magnitude of the task. First, every effort must be made to increase the crop production. Fertilisers, improved seeds, irrigation, and better methods of cultivation are already being used and must be pushed much further. Experimentation at the research level in agricultural field trials must be continued and developed with closer gearing to actual conditions of cultivation. Another possibility is the improvement of varieties through fundamental research in genetics. The spectacular increase in the yield of maize in the U.S.A. is a striking example of the success of such researches. Rice offers a promising field for similar work, and an increase of 25 per cent or 30 per cent in the yield is a definite possibility. Well-equipped centres for the study of rice genetics should be, obviously, established without delay. Here statistics can render effective help. In fact, in the field of agricultural experimentation and genetics, powerful methods like the design of experiments, the analysis of variance, and the theory of estimation are already available.

INCREASING DIFFICULTIES IN THE FUTURE

76. It is certainly necessary to attain self-sufficiency in food in 1951. But this is not enough. The production of food must keep pace with the growth of population. But not only food, it is also necessary to produce new houses, clothes, and thousands of other things in increasing quantities. Production must keep pace with population. The future trend of population in India is, therefore, a matter for serious concern. Available evidence indicates that at the existing level of production, the balance has already become adverse. A further and continual growth of population without a commensurate growth in the means of production will be disastrous. The only way is to develop our national resources.

INDUSTRIAL DEVELOPMENT

77. Rapid industrial development is one possibility. Government have already started work on a number of big multi-purpose dams for both irrigation and power. A beginning has also been made with machine tools and other basic industries and heavy chemicals. The building of houses, electricals, and other innumerable industries (including production of consumer goods) must be stepped up. All this would require capital goods in the way of plant and equipment, land and buildings, and labour.

78. It will be useful to obtain even a very rough idea of the capital requirement. The ratio of the gross value of the annual product to the capital investment varies widely from one industry to another. The ratio would be small in the case of iron and steel or basic industries; the gross value of the annual product may be something like one-third, or one-fourth, or even one-fifth of the invested capital. In electricals and lighter industries the ratio may be unity or even higher. Unfortunately very little information is available.[32] At a rough guess, the over-all value of the ratio is likely to be something between half and unity.

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[32] It may be noted that the over-all ratio of the annual value of the product to the invested capital is about 1.6 in the case of the industries covered by the Industrial Census of 1946 (Ministry of Industry and Supply). It must be remembered, however, that most of the capital investment took place long ago, while the annual product was valued at 1946 prices. If the value of the plant, machinery, and building is re-calculated at 1946 or current prices, the total amount of capital investment would be much higher than that actual shown in the returns. That is, the ratio would certainly fall much below 1.6.

79. It is also necessary to take into consideration what the economists call the 'multiplier' effect. To put it crudely, the multiplier stands for the additional value of products, and business and other activities stimulated by the increase in the primary product. (For example, an increase in the production of steel and cement may be expected to lead to an increase in the building of houses and construction work and other industries in an indirect way). No information is available about the value of the 'multiplier' in India. It is sometimes guessed that the multiplier may be something like 1.5 or so. To get a dimensional figure, we may perhaps assume that an investment of, say, one crore of rupees would lead to an increase of an equal amount in the national product (inclusive of the 'multiplier' effect). The actual ratio may be somewhat higher or somewhat lower, but this would give a rough dimensional picture.[33]

80. Consider the implications. To increase the value of the national product by one rupee per head per month or, say, twelve rupees per head per year, it is necessary to invest 420 crores of rupees (=Rs. 12 × 35 crores) or £310 million sterling. Compare this figure with the budget of the Government of India which is something like Rs. 320 crores (£240 million sterling) in 1949-50. Even if this whole amount is used for industrial development, the value of the national product is not likely to increase by more than, say, twelve annas or a rupee per head per month. It is clear that the Government of India alone can do very little. The industrial development of India depends entirely on the efforts which the people of the country are prepared to make.

THE NATIONAL INCOME

81. The next question which arises is the extent to which the people can afford to contribute to industrial development. Investing one rupee would bring a return of one rupee in future years; but whether one can afford to invest even one rupee depends on his income. This brings us to the question of the national income of India. Little reliable information is available.[34] Again one can only guess. Perhaps, the monthly income is Rs. 12/- or may be. Rs. 15/- per head. We do not know, but this may be the right order. We have also the other guess of 'a rupee for a rupee,' that is, a future national product of one rupee for a present investment of one rupee. The choice is definitely between jam today and jam tomorrow. We cannot have both. Indeed, unless we save and invest for the future, we may have less and less in future.

THE STATISTICAL POSITION

82. With meagre material I have constructed a dimensional picture which is admittedly very rough. It will have served its purpose, if it has conveyed to you some idea about the magnitude of the task in front of us. Secondly, if it has made you feel the urgent need of having more and better statistics. Along with the efforts to increase food production, attempts must be made to improve the statistics not only of the production of food but of its consumption and distribution. A gap of 10 years between population censuses is no longer tolerable. It is necessary that we should

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[33] It is assumed, of course, that the new capital investment is not in competition with existing investment, that is, does not divert any of the factors of production firm existing modes of production.

[34] Pioneer work was done by Dr. V. K. R. V. Rao who gave in 1940 an estimate of the natonal income for 1931-32; and in 1944 gave a tentative estimate for 1942-43. No authoritative estimates for recent years are yet available.

have information about the growth of population every year. We require information about the distribution of income and expenditure in different sectors of national economy, and in different strata of the population. We must, in fact, set about earnestly to develop a comprehensive system of social accounting for the whole nation.

83. Of capital requirements I have given a sombre picture. In one sense it is, however, not as dark as it looks at first sight. The capital investment is broadly of three kinds. First, machinery and equipment (and technical personnel) which we must import from abroad and must pay for ultimately in hard cash. Secondly, land and water, minerals, forests, livestock and animals, which we have in the country; and also buildings and material equipment which we have or which we can produce in India. And finally, man-power and labour which we have in abundance. In the beginning, the share of imported equipment from abroad must be necessarily heavy; but as the basic industries develop, this item should become smaller and smaller. The other two items, man-power and material resources, are our own. The imputed value entering into the capital account is, in a real sense, a matter of book-keeping. We can make what we like of these items. If the people and the Government are united in one common endeavour, then the human labour and the material resources in the country are completely at our disposal for national development.

84. If the statistical picture I have placed before you is not hopelessly wrong, then we are in difficult times and are probably facing greater difficulties than we have ever done in the past. The united effort of the Government with the people can save us. Such united effort can be brought about only by concerted action. To prevent waste of money, effort, resources, and most critical of all, to prevent, any further waste of time, planning on a national scale is essential.

NATIONAL PLANNING

85. National planning has several aspects. First, there is the preparation of plans at the technical level requiring the help and cooperation of workers in every branch of science and technology. Statistics is indispensible at this stage for the supply of basic information. Secondly, the individual plans have to be built into a general plan. Here statistics is the common denominator, and supplies the common binding medium for the whole. Thirdly, the plan has to be implemented. At this stage also, statistics can help in two ways. Firstly, by establishing scientific controls to ensure that the programme of action proceeds on efficient lines. Secondly, by conducting continuous assessments of the results by keeping account of the input of money, effort, and resources, and measuring what is obtained in return. The process is never-ending. In the actual working of the plan, defects are revealed, and new possibilities emerge requring consequential changes. Statistics is again invaluable in diagnosing weaknesses, in guiding controlled experiments, and in suggesting improvements. Statistics is thus pivotal in the dynamics of national planning. I hope you have now received a proper answer to the question: Why statistics?

RECENT DEVELOPMENTS IN INDIA

86. As I have already indicated, the progress of statistics must, depend upon and is closely determined by socio-economic trends. In India, we have seen during the last one year, hopeful signs of advance. A

Standing Committee of Departmental Statistics with representatives from the different Ministries of the Government of India was established in October 1948. A Central Statistical Unit was created, under the charge of a Statistical Adviser to the Cabinet, on the 28th January 1949. For the first time, a permanent office for the Census and Vital Statistics was established under a Registrar-General and ex-officio Census Commissioner in May 1949. A first comprehensive report on the industrial census of 1946 was published in July 1949. A National Income Committee was set up in August to review the position in this field and to make such estimates as may be possible. And the Central Statistical Unit was converted into a Central Statistical Organization on the 21st December 1949. All this indicates a move towards a more comprehensive review and formulation of the economic policy of the country. We may also hope to reach again, of course, in a more modern form, the state of development in statistics which was reached in India in the days of the survey of Eastern India in early 19th century, in the days of Akbar at the close of the 16th century, or in the days of Asoka in the third century B.C..

THE CHOICE BEFORE US

87. Our vast population is a great asset, but only in a potential form. In India we have every year a vast quantity of water in the form of rainfall. Most of it is wasted. Sometimes, in times of flood, it becomes a menace. But, by building dams and hydrels we can put it to work, and make it a source of power for fruitful production. In the same way, our vast man-power is at present lying mostly stagnant. A great deal remains idle, and a great deal is wasted in inefficient production. Perhaps it is wise to remember that, out of control, it may also become a menace fraught with grave dangers of self-destruction. But, if we can harness this living reservoir of power, there is nothing which we cannot accomplish.

88. So far attempts have been made to hire this power in a market place. We should think seriously whether we have the means, or the time, to continue to do so. Conditions are changing rapidly. It is a matter for serious thought whether or not the wiser policy would be to rally the common man into a great effort for national welfare. We look to our political leaders for guidance, decision, and action.

89. In a national plan, scientists and technologists also have to make their contributions. They can give the labour of their thought, and by the skill of their research and experimentation, show how to overcome difficulties and open out new possibilities. The statisticians have a humble role, but they also can help in reaching vital decisions. To this great ask I call all my friends and colleagues.

APPENDIX 1

SURVEY OF EASTERN INDIA : 1807-1815

[The following extracts are taken from the Introduction to "The History, Antiquities, Topography, and Statistics of Eastern India" by Montgomery Martin, London, 1838.]

The Survey of the districts of Behar and Patna, of Shahabad, Bhagulpoor, Dinajepoor, Goruckpoor, Puraniya, Rungpoor, and Assam, forming the Eastern territories of British India, and containing upwards of 60,000 square miles and nearly 15,000,000 of British subjects, was executed by the Supreme Government of Bengal, under orders from the Court of Directors of the Honourable East India Company, dated the 7th of January, 1807, wherein the Honourable Court observe, "We are of opinion that a statistical survey of the country, under the immediate authority of your Presidency, would be attended with much utility; we therefore recommend proper steps to be taken for carrying the same into execution."

The extent of the investigation will be seen from the directions issued for the guidance of the survey by the Supreme Government under date 11th Sept. which were as follows :—

"Your inquiries are to extend throughout the whole of the territories subject to the immediate authority of the Presidency of Fort William.

"The Governor General in Council is of opinion that these inquiries should commence in the district of Rungpur, and that from thence you should proceed to the westward through each district on the north side of the Ganges, until you reach the western boundary of the Honourable Company's provinces. You will then proceed towards the south and east, until you have examined all the districts on the south side of the great river, and afterwards proceed to Dacca, and the other districts towards the eastern frontier.

"Your inquiries should be particularly directed to the following subjects, which you are to examine with as much accuracy as local circumstances will admit.

'I. A Topographical account of district, including the extent, soil, plains, mountains, rivers, harbours, towns, and subdivisions : together with an account of the air and weather, and whatever you may discover worthy of remark concerning the history and antiquities of the country.

"II. The Condition of the Inhabitants; their number, the state of their food, clothing and habitations ; the peculiar diseases to which they are liable ; together with the means that have been taken or may be proposed to remove them ; the education of youth ; and the provision or resources for the indigent.

'III. Religion ; the number, progress and most remarkable customs of each different sect or tribe of which the population consists ; together with the emoluments and power which their priests and chiefs enjoy ; and what circumstances exist or may probably arise that might attach them to Government, or render them disaffected.

'IV. The Natural Productions of the Country, animal, vegetable, and mineral ; especially such as are made use of in diet, in medicine, in commerce, or in arts and manufactures. The following works deserve your particular attention :

'1st. The fisheries, their extent, the manner in which they are conducted, and the obstacles that appear to exist against their improvement and extension.

'2nd. The forests, of which you will endeavour to ascertain the extent and situation, with respect to water conveyance. You will investigate the kinds of trees which they contain, together with their comparative value and you will, point out such means, as occur to you, for increasing the number of the more valuable kinds, or for introducing new ones that may be still more useful.

"3rd. The mine and quarries are objects of particular concern. You will investigate their produce, the manner of working them, and the state of the people employed.

"V. Agriculture, under which head your inquiries are to be directed to the following points :

"1st. The different kinds of vegetables cultivated, whether for food, forage, medicine, or intoxication, or as raw materials for the arts : the modes of cultivation adopted for each kind ; the seasons when they are sown and reaped ; the value of the produce of a given extent of land cultivated with each kind. The profit arising to the cultivator from each, and the manner in which each is prepared and fitted for market. Should it appear that any new object of cultivation could be introduced with advantage you will suggest the means by which its introduction may be encouraged.

'2nd The implements of husbandry employed with the defects and advantages of each, and suggestions for the introduction of new ones, that may be more effectual.

"3rd. The manure employed for the soil, especially the means used for irrigation.

"4th. The means used for excluding floods and inundations, with such remarks as may occur to you on the defects in their management.

"5th. The different breeds of the cattle, poultry, and other domestic animals reared by the natives. The manner in which they are bred and kept the profits derived from rearing and maintaining them ; the kinds used in labour ; whether the produce of the country be sufficient, without importation, to answer the demand, or to enable the farmer to export ; and whether any kinds not now reared might be advantageously introduced.

"6th. Fences the various kinds that are used, and that might be introduced, with observations concerning the utility of this part of agriculture in the present state of the country.

"7th. The state of farms ; their usual size, the stock required, with the manner in which it is procured ; the expense of management the rent, whether paid in specie or in kind ; the wages and condition of farming servants and labourers employed in husbandry ; tenures by which farms are held, with their comparative advantages, and the means which, in your opinion, may be employed to extend and improve the cultivation of the country.

"8th. The state of the landed property and of the tenures by which it is held in so far as these seem to affect agriculture.

"VI. The progress made by the natives in the fine arts in the common arts and the state of the manufactures ; you will describe their architecture sculpture and paintings and inquire into the different processes and machinery used by their workmen and procure an account of the various kinds and amount of goods manufactured in each district. It should also be an object of your attention to ascertain the ability of the country to produce the raw materials used in them ; and what proportion, if any is necessary to be imported from other countries and under what adnvantages or disadvantages such importation now is, or might be made ; you will also ascertain how the necessary capital is procured, the situation of the artists and manufactures, the mode of providing their goods the usual rates of their labour ; any particular advantages they may enjoy, their comparative affluence with respect to the cultivators of the land, their domestic usages, the nature of their sales, and the regulations respecting their markets. Should it appear to you that any new art or manufacture might be introduced with advantage into any district, you are to point out in what manner you think it may be accomplished.

"VII. Commerce ; the quantity of goods exported and imported in each district the manner of conducting sales, especially at fairs and markets ; the regulation of money, weights, and measures ; the nature of the conveyance of goods by land and water and the means by which this may be facilitated, especially by making or repariing roads.

"In addition to the foregoing objects of inquiry, you will take opportunity of forwarding to the Company's Botanical Garden at this presidency, whatever useful or rare and curious plants and seeds you may be enabled to acquire in the progress of your researches with such observations as may be necessary for their culture."

APPENDIX 2

THE IDEA OF DETERMINATE KNOWLDGE IN ANCIENT INDIA

[The following is reproduced from the Editorial, *Sankhyā*, Vol. 1, Part 1 (June 1933), pp. 3-4.]

We are convinced that statistics represents a fundamental method of analysis of data in the mass which is applicable to any science of observation, and we feel that it is desirable to emphasize this essential unity in the methodology of statistics.

We believe that the idea underlying this integral concept of statistics finds adequate expression in the ancient Indian word *Sankhyā*. In Sanskrit the usual meaning is 'number,' but the original root meaning was 'determinate knowledge'[1]. In the Atharva-Veda a derivative form *Sankhyātā* occurs both in the sense of 'well-known' as well as 'numbered.'[2] The Lexicons give both meanings. Amara-kosa gives *sankhyā* = *vicāranā* (deliberation, analysis) as well as 'number;' also *sankhyāvān* = *panditah* (wise, learned).[3]

The same dual sense is attached to its derivative form *Sānkhya*[4] which is the name of the most famous analytic philosophy of ancient India. The name of the philosophical system is explained in both ways: as a philosophy based essentially on enumeration of the categories beginning with Nature or Root Cause. Or else a philosophy by which is revealed the adequate knowledge of reality.[5] The root meaning is also met with in the Mahabharata in the Gitā[6] portion where the *Sānkhya* system of philosophy is classifed with the Vedanta as being based on *jnāna* (or intellectual cognition) as distinguished from the Yoga systems. Sridhara in his commentary on the Gitā explains *Sānkhya* as *samyag-jnāna*, that is 'proper cognition' or 'adequate knowledge.'

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[1] The word can be written *samkhyā* or in a simpler form as *sankhyā*, the sound of *anusvāra* (nasal glide following a vowel) assimilating with the following sound of *k* and becoming a velar nasal (like *ng* in English *sing*). The simpler spelling also indicates the current pronunciation (like *sungkhi-āh*).

The word is derived from *khyā* (to 'perceive, view' ; to be known,' 'to make well-known' 'n Monier Williams's Dictionary). The root meaning is 'determinate knowledge', 'deliberation' or 'whatever helps us in obtaining determinate knowledge' accordiog as the *krt* suffix is taken in the active or instrumental form. From the latter phase is derived the technical meaning of 'number'.

[2] Atharva-Veda, 4.25.2. It also occurs in 4.16.5 and 12.3.28.

Winterintz after a full discussion of the date of the Vedic age says "we shall probably have to date the beginning of this development about 2000 or 2500 B.C., and the end of it between 750 and 500 B.C." *History of Sanskrit Literature* (English Translation, Calcutta University. 1927), Vol. I, p. 310. While the present form of the Atharva-Veda is believed to be later than that of the Rg-Veda, much of its material is considered to be as old as, if not older than, many portions of the Rg-Veda. (Winternitz, p. 127). The word *sankhyā* is in common use in the sense of number in the time of *Panini*.

[3] Amara-koṣa, 1.4.2 (*dhīvarga*). '*carcā sankhyā vichāranā*' (deliberation, reasoning, investigation). Also 2.7.5. (*Brahmavarga*) "*sankhyāvān paṇḍitah.*"

Monier Williams gives 'number, numeration ; deliveration, reasoning, reflection ; reason, intellect, understanding' under *sankhyā*.

[4] If is interesting to observe that the *Sankhya* teaches differentiation between spirit (*puruṣa*) and matter (*prakṛti*). plurality of souls, independence eternity of matter, and explains creation as an evolutionary unfolding of the world from original matter. (Winternitz, p. 434).

The history of the word *sankhyā* shows the intimate connexion which has existed for more than 3000 years in the Indian mind between 'adequate knowledge' and 'number.' As we interpret it, the fundamental aim of statistics is to give determinate and adequate knowledge of reality with the help of numbers and numerical analysis. The ancient Indian word Sankhyā embodies the same idea, and this is why we have chosen this name for the Indian Journal of Statistics.

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[5] In Vacaspatya we have '*mūla-prakṛtyādi-padārthānām gananā*' ('the enumeration of the categories beginning with Nature, the Root Cause'). Monier Williams gives 'relating to number or calculation; enumeration, deliberating, reasoning; rational, discriminative' under *sankhyā*.

In the commentaries *Sānkhya* is usually derived as '*samyak khyāyate vastutatvam anayā* ('by which is reavealed fully the essence or truth of reality.')

Fitz-Edward Hall (*Sānkhya-Sara*, Bibliotheca Indica, and quotes on p. 3, Dr. Röer in support: "The term *Sānkhya* has two meanings, enumeration and investigation." (*Lecture on the Sānkhya Philosophy*, p.8).

The dual significance of the word *sānkhya* is the subject of a pun in the opening couplet of Bhāskarācārya's *Bīja-ganita*, the well-known treatise on Algebra.

[6] Bhagavad-Gītā, 2.39. It is usually placed in the early centuries A.D, (Winterntz, p. 438).

APPENDIX 3

THE DOCTRINE OF INFERENCE IN INDIA

[The following extracts are taken from Brajendranath Seal's "The Positive Sciences of the Ancient Hindus", 1915.]

The Doctrine of Inference : Anumāna (Inference) is the process of ascertaining, not by perception or direct observation, but through the instrumentality or medium of a mark, that a thing possesses a certain character. Inference is therefore based on the establishment of an invariable concomitance (*Vyapti*) between the mark and the character inferred. The Hindu Inference (Anumāna) is therefore neither merely formal nor merely material, but a combined Formal-Material Deductive-Inductive process- It is neither the Aristotelian Syllogism (Formal-Deductive process), nor Mill's Induction (Material-Inductive process). But the real inference which must combine formal validity with material truth, inductive generalization with deductive particularisation. (pp.250-251).

....

The later Buddhists formulated the canon of a modified Method, termed the Panchakarani, a Joint Method of Difference, which combines the positive and the negative Methods of Difference (The Method of Addition and the Method of Subtraction) in a series of five steps, and which equally emphasises the unconditionality and the immediateness of the antecedents as essential moments of the causal relation. This is neither agreement in presence nor agreement in presence as well as absence (the foundation of J.S. Mill's Joint Method of Agreement), but the Joint Method of Difference. The Panchakarani runs thus:—

The following changes being observed, every thing else remaining constant, the relation of cause and effect is rigorously established:—

First step — The "cause" and the "effect" phenomenon are both unperceived.

Second step— Then the "cause" phenomenon is perceived.

Thrid step— Then, in immediate succession, the "effect" phenomenon is perceived.

Fourth step— Then the "effect" phenomenon is sublated or disappears.

Fifth step— Then in immediate succession, the "effect" phenomenon disappears. (pp.258-259)

APPENDIX 4

COMPARISON OF ESTIMATES OF JUTE ACREAGE IN BENGAL.

[The following note was prepared in 1947, at my request, by Dhirendra Mohan Ganguli then of the Indian Statistical Institute, Calcutta.]

	1944–45	1945–46
	(thousand bales)	
(1) Consumption during the season:		
(1.1) in jute mills (actual)	6,000	6,308
(1.2) exports (actual)	1,050	2,213
(1.3) in villages (estimate)	600	600
total	7,650	9,121
(2) Subtract quantity consumed from previous year's stock	– 324	– 697
(3) Subtract jute crop in other provinces	– 598	– 862
(4) Balance: Bengal crop from trade figures	6,728	7,562
(5) Bengal crop : official forecast (complete count)	4,895	6,304
(6) Bengal crop : sample-survey	6,480	7,540
(7) Discrepancy of official forecast on (4)	– 27.2%	– 16.6%
(8) Discrepancy of sample-survey on (4)	– 3.6%	– 0.3%

Source : Figures used in this table were taken from the *Final Review of the Jute Crop* (published by the Government of Bengal) ; and the *Monthly Summary of Jute and Gunny Statistics*, August 1946 and Jan. 1947 (issued by the Indian Jute Mills Association). One bale=400 lbs. of Jute.

NOTES ON CALCULATION (Paragraph numbers refer to serial numbers of items in the above table.)

(1.1) *Consumption in Jute Mills*: The Indian Central Jute Committee (ICJC), which is a statutory organization established by the Government of India, collects and publishes these figures every year. The Indian Jute Mills Association (IJMA) collects the figures from the member mills, and supply a consolidated statement to the ICJC. Mills outside the Association send their figures direct to ICJC. These figures are consolidated in the office of the ICJC, and two figures are published, one for the Association Mills and the other for the other Mills. The total is published in both the publications mentioned above, but as the *Final Review* was not published after 1946, the revised figures published by the IJMA were used in the present table.

(1.2) *Exports*: As exporters of raw jute have to pay a duty depending on the weight of jute exported, a very accurate account of the quantity of jute exported is kept by the Customs authorities. A daily list of exports showing quantities exported is published by the Customs authorities; and the consolidated annual figure is published in the "*Seaborne Trade of India*" by the Government of India.

(1.3) *Consumption in villages*: Several years ago this figure was fixed at 5 lakhs of bales by the IJMA. In 1941 a survey was conducted by the ICJC in collaboration with the Indian Statistical Institute to estimate the consumption in villages by a sample enquiry, and the figure was changed to 6,00,000 (6 lakhs) bales on the basis of the above enquiry. Both IJMA and the Government of Bengal accepted this figure, and used it in the two publications mentioned above.

(2) *Quantity consumed from previous year's stock*: The next step is to deduct the quantity consumed from previous year's stock from the total consumption during the year.

According to an Act passed by the Government of Bengal in 1941 all jute mills, jute balers, and jute dealers have to submit a return showing the stocks of jute with them on the 30th June every year. For several years there was a Special Officer (Jute) in the Government of Bengal, in whose office these figures were compiled. Actual figures were collected from the mills and balers and dealers of Calcutta and the neighbouring industrial area while estimates were prepared for the stocks held by muffasil dealers and growers on the basis of reports received from the District Agricultural staff.

Calculation of consumption from previous year's stock

	1944–46	1945–46
	(thousand bales)	
(2.1) Stock at the beginning of the season:		
(2.11) with IJMA mills	2,342	2,712
(2.12) with other mills	83	114
(2.13) with growers	466	150
(2.14) with muffasil dealers	816	475
(2.15) with Calcutta balers and dealers	643	575
total (2.1)	4,350	4,026
(2.2) Stock at the end of the season:		
(2.21) with IJMA mills	2,712	2,604
(2.22) with other mills	114	105
(2.23) with growers	150	82
(2.24) with muffasil dealers	475	160
(2.25) with Calcutta balers and dealers	575	378
total (2.2)	4,026	3,329
Decrease in stock: (2.1) — (2.2) (consumption of old stock during the year)	324	697

(3) *Jute crop in other provinces*: This is estimated by the respective Provincial Directors of Agriculture. Plot-to-plot enumeration of the jute crop alone was undertaken in these provinces during the years 1939-43; and the subsequent estimates were prepared on the basis of the above plot-to-plot enumeration and local information obtained every year through the staff deputed for this work. The figures for Bihar include the crop from Nepal which finds its way to the Indian market through Bihar. The figures were taken from the *Final Jute Forecast*.

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SECTION OF MATHEMATICS

PRESIDENT : N. M. BASU, D.Sc.

Presidential Address

MATHEMATICS AND MATHEMATICAL STUDIES IN FREE INDIA

I deeply appreciate the great honour that has been done to me in electing me to preside over the deliberations of the section of Mathematics of the current session of the Indian Science Congress. It is not merely a great honour,—it is also a rare privilege to have the opportunity of addressing such a galaxy of distinguished scientists who have assembled here from all parts of this country as well as from several foreign countries representing some of the most scientifically advanced nations of the world. I must however freely confess that I felt not a little perplexed when I pondered over the main obligation that I would be required to discharge, namely, that of preparing and delivering a Presidential address ; for, the choice of a suitable subject appeared to me somewhat difficult . The usual practice followed by past Presidents has been to select some highly specialised topic of Mathematics for their addresses and this has almost established a tradition, and it is no easy matter to break away from tradition. It was open to me to follow in their footsteps, but it seems to me,—and I have formed this impression from my personal experiences on many such occasions,—that at a gathering like this, which is likely to include, in addition to some mathematical luminaries, a large number of other scientists whose main interest is not mathematics and a fair number of young graduates and students as well, a talk on a very restricted field of the subject would not perhaps be very suitable, as such a talk would be rather highly technical and could be followed with interest by only a limited few while the large majority of the audience would find it dull and uninteresting. A general survey of the subject, on the other hand, covering the entire field, which would necessarily contain some things of interest to almost every one of the audience, would perhaps be more appropriate on an occasion like this. But unfortunately,—or shall I say, fortunately for our subject,--Mathematics is so ancient and its field of study so vast that I feel quite unequal to the task of attempting such a survey, for it would perhaps require hours to give anything like even a rough idea of its achievements or of the manifold directions in which it is rapidly growing . As such a general survey is out of the question in view of the shortness of the time at my disposal, I have decided to confine myself to some general remarks about Mathematics and Mathematical Studies in Free India. It is not my intention to give any learned discourse for consumption at high level, nor do I claim to say anything particularly original. In deviating from the beaten track, therefore, I must crave the indulgence of the learned professional mathematicians who are assembled here and who may not be a little bored by the somewhat rambling talk that I may be giving.

What then is this Mathematics,—this Queen of the Sciences as it is said to have been styled by Gauss? Is this really an apt description of the Science and, if so, how ? Or, is it not more sensible to call it the "Handmaid of the Sciences" as it has also been described by many? Is there any sense in which the study of the subject is profitable either to the individual or to the society or to the State ? Or, are those engaged in Mathematical Studies merely wasting their time and energy in idle and fruitless speculations which are of no use to anybody ? Why is it that very few of the most capable among the young men of our country, who are endowed with the highest intellect, take to Mathematics as a profession ? These are some of the questions which I shall try to answer in this discourse. Such questions are not new. They have been asked in other countries and answers have been given by professional mathematicians and philosophers interested in mathematics as well as by other great educationists. I am not however aware that the general public in this country has ever given any serious thought to such questions or demanded answers to them. It seems to me that no earnest attempt has ever been made by even the educated public in this country to understand the nature of the subject or the various aspects of mathematical studies and their relations to other fields of study, and the influence of mathematics on present-day civic life. Nor has any attention been paid to the need for improvement in the curricula and methods of teaching of mathematics, particularly of high school mathematics, as has been done from time to time in other countries. The main purpose of my address today is to focus public attention on such questions as have been mentioned above so that the various bodies and administrators responsible for the organisation and functioning of our educational system may be moved a little from their hitherto complacent attitude and do something for the re-organization and re-orientation of mathematical studies in this country. I also hope that some parts of my address may help our young friends,—the mathematicians of the future,—to have a better appreciation of the true nature of our subject and induce them to pursue their studies and research with greater zeal and energy, and that they will realise that after all they belong to one of the noblest of professions and are really not members of that curious species of human beings, cranky and idiosyncratic, as they are generally supposed to be.

To describe in precise language what Mathematics is, is an almost insuperable task. It is almost as undefinable as some of its basic concepts like point, line, angle etc., for after all these are the constituents out of which the science is constructed. Attempts have, however, been made by various thinkers to give some idea of the content of Mathematics by broadly dividing it into two categories, namely, Pure and Applied. Said Francis Bacon[1] "Mathematic is either Pure or Mixed. To Pure Mathematic belong those sciences which handle Quantitiy entirely severed from matter and from axioms of natural philosophy. Mixed Mathematic has for its subject some axioms and parts of natural philosophy, and considers quantity in so far as it assists to explain, demonstrate and actuate these". According to Sylvester[2], "the object of pure physic is the unfolding of the laws of the intelligible world ; the object of pure Mathematic that of unfolding the laws of human intelligence". "Pure Mathematics", says Bertrand Russell[3], "is the class of all propositions of the form 'p implies q', where p and q are propositions containing one or more variables, the same in the two propositions, and neither p nor q contains any constants except logical constants. In addition to these, Mathematics *uses* a notion which is not a constituent of the propositions which it considers—namely, the notion of truth." "Mathematics", according to Howison[4],—and here obviously Applied Mathematics is meant,—"is that form of intelligence in which we bring the objects of the phenomenal world under the control of the conception of quantity". These are only a few samples of the numerous descriptions and definitions that have been given by various learned men at different times. Perhaps it will not be very inaccurate to say that Pure Mathematics is the mathematics of the spirit while Applied Mathematics is the mathematics of matter, the one is a thing having its root in the mind while the other has its root in the external world, the former is built mainly on ideas and imaginations while the latter is built mainly on observations and perceptions of the universe around us through our senses, that Pure Mathematics, specially in its higher parts, is more an art than a science, while Applied Mathematics is more a science than an art, Pure Mathematics is the flower of the tree of Mathematical knowledge while Applied Mathematics is its fruit. The various definitions that have been given more or less reflect the mode of thought pursued by those who have given those definitions and have been somewhat coloured by their personal attitudes towards the content of Mathematics. And the very fact that so much thought has been given to the exposition of the contents and objectives of mathematics shows that the concepts and purposes of mathematics have not always been easy to understand. Thus while Felix Klein[5] declared that "Mathematics in general is fundamentally the Science of *Self-evidents* (selbstverständlichen)", we have Alfred Pringsheim[6] declaring, "Experience however shows that for the majority of the cultured, even of scientists, mathematics remains the science of the *incomprehensibles* (unverständlichen)".

From what I have said above about Pure Mathematics and Applied Mathematics as forming the two broad categories into which Mathematics is divided, it might be thought that they are really two distinct branches of knowledge separated from each other into water-tight compartments. As a matter of fact, however, they are not so. The two are complementary to each other and form together one great, if not the greatest, achievement of the human mind. They go hand in hand each supporting, nourishing and enriching the other, and helping each other in their onward march of progress. Pure-Mathematicians supply the tools which Applied-Mathematicians apply to problems of Nature, and just as the needs of a craftsman who sometimes finds his tools inadequate for his purposes lead to the devising and invention of new and improved tools, so also the needs of the applied-mathematicians often lead to the emergence of new notions and inventions of new branches of Pure-Mathematics. A simple instance, but none the less significant on account of its apparent simplicity, is that of the notion of *function*, "that flower of modern mathematical thought," as McCormack[7] puts it. The notion of a *function* in its modern form, which is indeed the soul of modern analysis, owes its origin to investigations of applied-mathematicians. It is true that the notion of functionality, that is the relation of one variable to another, probably goes back to Descartes but it does not appear that he anywhere used the word *function* explicitly. Moreover his concept was limited to continuous functions only, such as are met with in Analytical Geometry. It is now believed that the word was first introduced in 1694 by Leibnitz[8] and was subsequently used by James Bernoulli[9] in a somewhat general sense. Euler[10] was perhaps the first to use the now familiar notation of $f(x)$. He defined a *function* of a variable quantity as "an analytical expression composed in some way of that variable quantity and of numbers or constant quantities". This definition still lacks the generality of the modern notion of a function. The necessity for an extended notion of a function was first felt by D'Alembert and Fourier in their investigations on problems of applied mathematics, namely, the vibrations of stretched strings and the conduction of heat. It was Fourier who first conceived the notion of a *single function defined in different parts of an interval by different expressions* and the credit of giving almost the present day shape to the notion of a function goes to Lejeune Dirichlet[11] who was led to his definition in connection with his investigations on the convergence of Fourier Series and thus laid the foundation of the modern theory of functions.

The above is only one of various instances which can be given to show that many brahches of pure mathematical studies have their birth in ideas derived from the pursuit of Applied Mathematics. Indeed the whole science of Geometry may be said to have originated in Applied Mathematics since it arose out of investigstions in the spatial relations of material objects. The science of Infinitesimal Calculus,—at any rate the rapid progress of it,—may be ascribed to the need for suitable mathematical tools for the study of problems of Astronomy and Mechanics. Speculations in Pure Mathematics, on the other hand, have often given rise to startlingly revolutionary theories in Applied Mathematics. Thus the General Theory of Relativity propounded by Einstein would probaly have been delayed very considerably, had not the field been prepared, as if solely for this purpose, by the development of Tensor Analysis by Riemann and Christoffel and of the Absolute Calculus by Ricci and Levi-Civita. It is therefore essentially senseless to regard Pure and Applied Mathematics as divorced from each other. "Progress has brought about", says Nunn[12], "and, indeed, has required division of labour. A Lagrange or a Clerk Maxwell is chiefly concerned to enlarge the outer dominion of mathematics over matter; a Gauss or a Cantor seeks rather to perfect and extend the minor realm of order among mathematical ideas themselves. But these different currents of progress must not be thought of as independent streams. *One never has existed and never will exist apart from the other.* The view that they represent wholly distinct forms of intellectual activity is partial, unhistorical, and unphilosophical."

In the domain of Pure Mathematics again we talk of the different branches of it, as if they entailed altogether different lines of thought. Geometry, for instance, is sometimes supposed to be essentially different from Analysis. This however is not really so. "Sylvester remarked as curious," so says MacMahon[13], "that notwithstanding he had always considered the bent of his mind to be rather analytical than geometrical, he found in nearly every case that the solution of an analytical problem turned upon some simple geometrical notion, and that he was never satisfied until he could present the argument in geometrical language." Indeed a wonderful advance in Geometry has been brought about in recent times by the powerful tools of research of modern Analysis. All mathematics, in fact, is organically united inspite of apparent diversities in its contents. As Hilbert[14] said: "Mathematical Science ...... is an indivisible whole, an organism whose vitality is conditioned upon the connection of its parts. ...... The farther a mathematical theory is developed, the more harmoniously and uniformly does its construction proceed, and unsupected relations are disclosed between hitherto separated branches of the science."

Let us now consider for a moment some of the functions and characteristics of mathematical knowledge. As Applied Mathematics consists in the applications of Pure Mathematics I shall confine my remarks only to Pure Mathematics which I have described as the flower of the tree of mathematical knowledge.

In the first place, Mathematics is a sort of language which enables us to express our conceptions about spatial relations and quantity in a manner which can be easily understood. According to Henri Poincaré[15], "Without this language most of the intimate analogies of things would have remained forever unknown to us; and we should forever have been ignorant of the internal harmony of the world, which is the only true objective reality." Indeed Mathematics is perhaps the most perfect vehicle for the communication of human thought in as much as mathematical language is concise and at the same time precise, leaving no room for vagueness or ambguity. Hence it is the language of all the sciences,—physical, chemical, biological, social and even mental. "Through it, as it were, nature herself speaks; through it the Creator of the world has spoken, and through it the Preserver of the world continues to speak."[16] Indeed most of the physical sciences and a great deal of the essentials of the other sciences as developed today must remain unintelligible and shrouded in mystery to those who have not received adequate training in mathematical analysis. The language of mathematics is naturally condensed embodying, as it does, the result of a great deal of thinking in the form of formulas and equations and, as Pringsheim[17] puts it, "the mathematician who knows how to think in this marvellously condensed language is as different from the mechanical computer as heaven from earth."

Mathematics is, however, not merely a language to the scientist,—it is the most powerful tool in his hands which enables him to probe into the secrets of nature in his attempts to discover what he regards as the 'Laws of Nature.' This use of Mathematics as a tool is however looked down upon by many mathematicians, particularly those with a philosophical bent of mind, while others have equally severely condemned all speculative mathematics having apparently no practical value. Thus we have from Macaulay's writings[18]: "The opinion of Bacon on this subject (Geometry) was diametrically opposed to that of the ancient philosophers. He valued Geometry chiefly, if not solely, on account of those uses which to Plato appeared so base.......He condemned with severity the pretensions of the mathematicians, '*delicias et fastum mathematicorum.*'......Mathematical Science, he says, is the handmaid of natural philosophy; she ought to demean herself as such; and he declares that he cannot conceive by what ill chance it has happened that she presumes to claim precedence over her mistress." We have on the other hand the following[19] about Archimedes; "Archimedes was not free from the prevailing notion that geometry was degraded by being employed to produce anything useful. It was with difficulty that he was induced to stoop from speculation to practice. He was half ashamed of those inventions which were the wonder of hostile nations, and always spoke of them slightingly as mere amusements, as trifles in which a mathematician might be suffered to relax his mind after intense application to the higher parts of his science." Now whatever may be said for or against the use of mathematics as a tool,—and everybody is well aware of the marvellous achievements of science to the lasting benefit and welfare of humanity made possible by such use,—there is no gainsaying the fact that the use of mathematics as a tool has led to great advancements of Pure Mathematics. The Applied-Mathematician need therefore have no reason to be ashamed of his activities, indeed he may be well proud of them. He may very well remind the Pure-Mathematician that perhaps the greatest achievement of the human intellect was the discovery of the law of universal gravitation, an achievement of the applied mathematician in Newton. Thus it is idle to decry the employment of Pure Mathematics as a tool, for it is this very use which has in a great measure contributed to the progress of mathematics as pure thought.

While mathematics is no doubt a language as well as a tool, the real nature of mathematics far transcends these aspects of it, although to the uninitiated, perhaps those are the very aspects which would be more appealing than anything else. "Mathematics," said Henri Poincare[20], has a triple end. It should furnish an instrument for the study of nature. Furthermore it has a philosophic end, and, I venture to say, an end esthetic. It ought to incite the philosopher to search into the notions of number, space and time; and, above all, adepts find in mathematics delights analogous to those that painting and music give....... Hence I do not hesitate to say that mathematics deserves to be cultivated for its own sake, and that the theories not admitting of application to Physics deserve to be studied as well as others." Indeed Mathematics can be truly regarded as a fine art. It is said[21] that music had been classed as a branch of mathematics for at least two thousand years until about the year 1500. Like every other fine art, mathematics has an ennobling influence on the human soul, the value of which is inestimable. The great joy and thrill which a mathematician experiences when he hits upon a brilliant new idea is simply indescribable. He has, at any rate for the time being, an escape from the entanglements of the mundane affairs of the world and almost loses himself in a trance. I had once been talking to a friend who is a teacher of literature and he told me that he had found mathematics very dull and uninteresting and could not understand how any one could be interested in it. I thought I would give him a very simple and easily understandable illustration and asked him to verify and contemplate the following equations:

$$1^3 = 1^2$$
$$1^3+2^3 = (1+2)^2$$
$$1^3+2^3+3^3 = (1+2+3)^2$$

He agreed that the equations were correct and appeared to be interesting. I asked him whether he would not infer anything from the above and he immediately said that he was wondering whether it was not also true that

$$1^3+2^3+3^3+4^3 = (1+2+3+4)^2$$

When I assured him that it was true and that the inference could be easily extended to any number of consecutive positive integers starting from 1, he was surprised and thrilled to find that the natural numbers which seemed to be devoid of any beauty had such a beautiful property, full of symmetry and harmony. This of course is a trivial illustration to show that even a non-mathematician can appreciate the beauties of mathematics and be thrilled and delighted by such experience. The joy of the person who hits upon a new idea and invents a new theorem of mathematics is like that of an artist who creates something out of his imagination or of a musician who composes a beautiful symphony in which his very soul, as it were, tries to find expression. Thus when Bolyai, while still a student at Vienna, had conceived the idea of an Absolute Geometry which would contain Euclidean Geometry as a special case and had worked out the main ideas of non-Euclidean Geometry based on a new theory of parallels, he wrote to his father expressing his desire to publish the results of his investigations on the theory of parallels, "for", he wrote[22], "I have made such wonderful discoveries that I am myself lost in astonishment, and it would be an irreparable loss if they remained unknown. When you read them, dear Father, you too will acknowledge it. I cannot say more now except that out of nothing I have created a new and another world. All that I have sent you hitherto is as a house of cards compared to a tower." He found the investigation of the famous parallel postulate so interesting and exciting that he pursued it "inspite of his father's solemn adjuration to let the loathsome subject alone." Similar joy and excitement must be experienced by every mathematician who conceives a new idea and creates something new in the realm of mathematical knowledge. Mathematics, like poetry, is a a creative art and not merely a collection of formulas or statements of what are called "mathematical truths." Hence it is that imagination plays such an important role in the progress of mathematics. Says Thomas Hill[23]: "Mathematics and Poetry are ... the utterance of the same power of imagination, only that in the one case it is addressed to the head, and in the other, to the heart." And again[23], "Mathesis and Poetry are of the closest kindred, for they are both works of the imagination. Poesy is a creation, a making, a fiction; and the Mathematics have been called, by an admirer of them, the sublimest and most stupendous of fictions." According to Voltaire[24], "there was far more imagination in the head of Archimedes than in that of Homer." Indeed Mathematics has a great deal in common wtih the fine arts. From it the human mind derives through the intellect essentially the same kind of pleasure as it does from a piece of painting through the eye, or from a piece of music through the ear. It is moreover the most innocent of such pleasures, being a spiritual pleasure having nothing to do with the senses, while the pleasures derived from painting or music may be said to have something of the sensual about them.

A little while ago I gave a very simple illustration of beauty in mathematics. Indeed many of the theorems of mathematics are extremely beautiful, their beauty consisting in their simplicity and often in the harmony of their contents. "A peculiar beauty reigns in the realm of mathematics." says Kummer[25]," a beauty which resembles not so much the beauty of art as the beauty of nature." Says Bertrand Russell:[26] "Mathematics, rightly viewed, possesses not only truth but supreme beauty—a beauty cold and austere, like that of sculpture, without appeal to any part of our weaker nature, without the gorgeous trappings of painting or music, yet sublimely pure, and capable of a stern perfection such as only the greatest art can show." No one can fail to be deeply impressed and fascinated by the beautiful contents of many of the theorems of Geometry, as such theorems can be visualised to a great extent and the beauties of them thus perceived easily. The beauty of the famous Pythagorean theorem of the right-angled triangle is an almost unsurpassable one, so much so that it formed the subject for the composition of a poem. But beauty in mathematics is not confined to Geometry alone. Here is another illustration from the domain of numbers:

Consider the following two sequences of positive integers:

(A) 1, 3, 6, 10, 15, 21, 28, 36, 45, 55, 66, 78, ...

(B) 1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, 144, ...

The first sequence (A) is the sequence of what are known as the triangular numbers while the second (B) is the sequence of squares. Looking at the two sequences as far as written above one sees that 1 and 36 are the only two numbers occurring in both (A) and (B) and one can easily verify that there are no other numbers among the first 48 numbers of (A) which also belong to (B), the next number having this property is the 49th number which is $1225=35^2$. It is only natural to feel a little curious and ask the question "Are there other common members of (A) and (B), i.e. are there other numbers besides 1, 36 and 1225 which are triangular as well as square? Are there a finite or an infinite number of such numbers and how can they be determined?" Now the answer to these questions is completely contained in the symbol $\sqrt{2}$. One might at first feel surprised and ask, "what has the irrational number $\sqrt{2}$ got to do with the question which concerns two special subsets of the natural numbers?" All the same it is true that $\sqrt{2}$ contains the complete answer to the question and this is how it does: Let $\sqrt{2}$ be expressed as a simple continued fraction and let its successive convergents be written out in a sequence. This sequence is:

(C) $\frac{1}{1}, \frac{3}{2}, \frac{7}{5}, \frac{17}{12}, \frac{41}{29}, \ldots\ldots\ldots\ldots$

The sequence can be easily written down to any number of terms by the simple rule that the numerator of any term beginning from the third is obtained by multiplying the numerator of the preceding term by 2 and adding the result to the numerator of the next preceding one. The same rule applies to the demominators also. Thus for the 5th term $\frac{41}{29}$, we have

$41 = 2\times 17+7$

$29 = 2\times 12+5$

Now it can be proved without much difficulty, though not quite trivially, that the only numbers which are both triangular as well as square are those of the infinite sequence

(D) $(1.1)^2, (3.2)^2, (7.5)^2, (17.12)^2, (41.29)^2, \ldots\ldots\ldots\ldots$

These are respectively the 1st, 8th, 49th, 288th, 1681st, ... triangular numbers as well as the 1st, 6th, 35th, 204th, 1189th, ... square numbers. A glance at (C) shows how the terms of (D) are derivable from the corresponding terms of (C).

I have, in the preceding lines, often spoken of 'mathematical truths' and 'natural laws'. There is however a good deal of misunderstanding about the sense in which the words 'truth' and 'law' are generally used and a few words about them may not be altogether out of place. The word 'law' in common parlance means something which has necessarily to be obeyed by the objects to which they apply. Similarly the word 'truth' usually implies an attribute which is of an objective nature and a true proposition is supposed to be one which cannot be controverted by anybody under any circumstances. These words, however, have slighly different meanings in mathematics. A 'law of nature' in reality means a description in mathematical language the results of various observations regarding the behaviour of certain physical entities under similar circumstances. Some hypothesis regarding the properties of those entities is made to explain their behaviour and the hypothesis is tested by further observations and experiments, and if the results of the experiments, carried out with the help of such apparatus as are at the command of the scientists at that time, agree with the theoretical results obtained by calculations on the basis of the hypothesis, then the hypothesis is called a 'law'. Thus the laws of applied mathematics, are not really entirely of an objective nature as they depend on so many other factors. Hence they have to change with the progress of science and refinement of the methods of measurement of observed quantities. Sometimes the laws are only slightly modified and sometimes they have to be totally discarded, perhaps to be re-accepted, at least partially, in a new garb. It is therefore not quite correct to think of what is called a law of nature as something like a permanent, ultimate and incontrovertible truth. "In most sciences," says Hermann Hankel[27] "one generation tears down what another has built and what one has established another undoes." Indeed the formulation of new laws are sometimes based on ideas which completely revolutionise the current notions of the physical world. Thus Newton's laws of mechanics and his law of gravitation brought about a revolution in the sense that these gave us probably for the first time an absolute space and an absolute time, independent of each other, and the doctrine of invariability of mass. Another and perhaps even greater revolution was brought about when nearly two centuries after the death of Newton, Einstein propounded his General Theory of Relativity which dashed to the ground all the above three concepts about space, time and matter. On the other hand it is well known how Newton's theory of light as being composed of fast moving particles was discarded in favour of a Wave Theory according to which light consisted merely in the vibrations of an all-pervading medium, the ether, and how again in the recent past the theory of light-quanta all but resuscitated the corpuscular theory from its grave. "The certainties of Science," says Whitehead[28], "are a delusion. They are hedged around with unexplored limitations." The laws of nature have therefore to be constantly sent back to the crucible and recast in the light of new experiences, observations and improved measurements. Thus writes Bertrand Russell[29] about laws of nature: ' 'The theory of relativity has shown that most of traditional dynamics, which was supposed to contain scientific laws, really consisted of conventions as to measurement, and was strictly analogous to the "great law" that there are always three feet to a yard. In particular, this applies to the conservation of energy. This makes it plausible to suppose, that every apparent law of nature which strikes us as reasonable is not really a law of nature, but a concealed convention, plastered on to nature by our love of what we, in our arrogance, choose to consider rational." A mathematical truth, or what is sometimes called a law of mathematics, stands, however, on a somewhat different footing. Even so, there are some apparently conflicting views which, it seems to me, arise not so much from the intrinsic nature of the matter as from the angle of vision from which we look at it. Bertrand Russell[30], for instance, holds the view that "Pure Mathematics consists entirely of such asservations as that, if such and such a proposition is true of *anything*, then such and such another proposition is true of that thing. It is essential not to discuss whether the first proposition is really true, and not to mention what the *anything* is of which it is supposed to be true. . . . . Thus mathematics may be defined as the subject in which we never know what we are talking about, nor whether what we are saying is true." Nobody would however deny the intrinsic truth of the Fundamental Theorem of Arithmetic, namely, that every natural number, i.e. a rational positive integer, except 1 is, apart from the order, uniquely representable as a product of the natural primes, or of the statement that 2+2=4. Such statements are of the nature of absolute and eternal truths about the objects or concepts to which they apply. Pure Mathematics, however, does not consist essentially of absolute or eternal truths in the above sense, for much of the truths of modern mathematics can be styled as such only in a relative sense, although in a somewhat limited sense they may also be described as absolute truths. As a matter of fact in most cases, it is perhaps non-sensical to ask whether a certain mathematical result is either true or false. For instance, it is non-sensical to ask whether the statement $(a+b)^2 = a^2+2ab+b^2$ is true or false unless it is specified what a and b stand for. Mathematicians, however, for a long time believed in the absolute truth of mathematical theorems in the sense of their infallible applicability to human experiences of the physical world although occasionally there have been some sceptics who have questioned such dogmatic beliefs. But this view about the absolute character of mathematical truths was perhaps finally abandoned only after the invention of non-euclidean Geometry by Bolyai and Lobachewsky who showed that there could be consistent geometries other than the Euclidean which might be just as true or as false in their applications, but so far as they were constructions of mathematical systems based on well defined elements and postulates, each was as true as any other; in fact each might be regarded as absolutely true in its own world of ideas. "Modern Mathematics", we may agree with Huxley[31], "is that which knows nothing of observation, nothing of experiment, nothing of induction, nothing of causation," in so far as modern pure mathematics is born of imagination and inspiration of the mind rather than of experiences of nature, although it may be true that the inspiration often comes from such experiences; as for instance, Euclidean Geometry derives its inspiration from spatial experiences. Fired with an inspiration, the pure-mathematician weaves his ideas into a pattern utterly regardless of any consideration of application or profit. Whether the pattern woven by him has any counterpart in Nature is a matter of supreme indifference to him. Whether the natural phenomena to which his system is sought to be applied agrees with the pattern evolved by him or not is of no significance since the pattern was created for its own sake and not with the purpose of interpreting any natural phenomenon by a reference to it. Disagreements therefore do not falsify his system in any sense,—the system in its own framework remains eternally true.

Another aspect of mathematical activity consists in its being perhaps the most harmless of human activities. It is not actuated by any ulterior motives, nor contaminated by any earthly desires, for it does not concern the material world at all. As Hardy[32] says: "Both Gauss and lesser mathematicians may be justified in rejoicing that there is at least one science, and that their own, whose very remoteness from ordinary human activities should keep it gentle and clean."

Thus Mathematics being an embodiment of "সত্যম্ শিবম্ সুন্দরম্" the true, the good and the beautiful,—the three principal attributes of Godhood in Hindu Philosophy,—is perhaps the one Science, the disinterested and devoted pursuit of which, more than that of any other, takes man nearer to his Creator.

Now it may very well be asked, if mathematics has really the attributes described above, why is it then that it has so few votaries in this country,—this land with its rich and splendid heritage of spiritualism from time immemorial? My answer is that there are many factors responsible for this, but perhaps the most potent factor is the present general attitude of the people towards the need for the acquisition of mathematical knowledge and its place in a general scheme of education. Most people seem to think that the teaching of higher mathematics is wasteful and that it is enough for all ordinary purposes to learn the elementary rules of Arithmetic. There is accordingly a demand in some quarters for reducing the curriculum in mathematics for the Matriculation Examination to elementary Arithmetic only. Let us therefore consider a little the place and scope of mathematics in the High School curriculum. It seems to me that sufficient serious thought has never been given to this question. Perhaps this may be accounted for by the fact that due to two centuries of slavery and an educational system imposed on us by considerations other than the genuine welfare and progress of the people we were not free either to chalk out our own programme of education or, even if we could do so, to enforce it. Now, however, conditions have changed, our country is free and Free India demands an immediate and searching examination of our educational problems and a re-casting of our educational system in a form that will enable us to occupy an honourable and important place in the comity of nations at the earliest possible date. Our people, unfortunately, are not well informed in educational matters and we must admit, with shame, that we, who belong to the teaching profession, have done next to nothing to see that they are better informed about our subject. We have no organisation like the National Council of Teachers of Mathematics of the United States of America or the Mathematical Association of the United Kingdom, nor any journal of the standard of the Mathematics Teacher or the Mathematical Gazette through which we could come into contact with school teachers and the general public and acquaint them with our aims and ideals. And no plan of reform in any field can be effective unless it has sufficient support of the general public.

Now, what is the real purpose for which mathematics is or should be taught? Is it justifiable to include it as a compulsory subject in the high school curricula for all students when it is well known that a large percentage of the matriculates will never require the use of it in the discharge of their vocations? The following extract[33] from the Report of the National Committee on Mathematical Requirements of the Mathematical Association of America perhaps gives an adequate answer:

> "The primary purposes of the teaching of mathematics should be to develop those powers of understanding and of analyzing relations of quantity and of space which are necessary to an insight into and control over our environment and to an appreciation of the progress of civilisation in its various aspects, and to develop those habits of thought and of action which will make these powers effective in the life of the individual."

There is of course also what may be called a secondary purpose, though not applicable to all, namely that of equipping the students for training in the technical sciences which is so necessary for the material welfare of humanity at large and also, in a somewhat narrower sense, for the management of statecraft and defence of the nation. But it is essentially for the primary purposes mentioned above that mathematics of a fairly high standard has an important and almost mandatory place in any scheme of general education in every progressive country of the world. Unfortunately this has not been properly understood or appreciated by the educated public in this country who still think of Mathematics as a computer's art and do not realise that[34], "Mathematics is no more the art of reckoning and computation than architecture is the art of making bricks or hewing wood, no more than painting is the art of mixing colours on a palette, no more than the science of geology is the art of breaking rocks, or the science of anatomy the art of butchering." This aspect of the aim of teaching mathematics will perhaps not be properly recognised by any but a very limited circle of our people until school Mathematics is sufficiently reformed and the curriculum and standard of teaching are made of a slightly more advanced character in order to provide some inkling of the vital role which mathematics plays in modern life and the profound influence it has brought to bear on all departments of thought. "In the Secondary Schools," says H.G. Wells[35], "Mathematics should be a part of general culture and not contributory to technical training of any kind. . . . . Mathematics is a quite indispensable factor of general education in so far as the latter shows its traces in the comprehension of the development of civilisation and the ability to participate in the further tasks of civilisation." It is therefore necessary to reform school education suitably so as to introduce the notion of functionality even at the school stage for, as Klein said, "the world is being functionally minded" and without a notion of functionality it is not possible for anyone to understand modern civilisation and its trends. It will be pointed out, I know, that the curriculum of school mathematics is heavy enough and nothing more can be added to it. But that is exactly my point,—it is loaded with a good deal of rubbish which can be safely scrapped. This should be done and a reformed and revitalized curriculum should be framed as early as possible. The movement for reforms in the curricula and methods of teaching of mathematics first started in Germany more than a century ago in 1816, when the programme known as the Prussian Lehrplan was formulated. What wonder then that Germany became the home of mathematical learning and the Germans more scientifically advanced than all other nations? This Lehrplan however did not prove quite satisfactory and had to be modified from time to time. The reform movement continued and in 1873, when the country had begun to settle down after the Great War of 1871, the Prussian Minister of Education summoned a conference to discuss the question of mathematicl education in all its bearings. At about this time the movement spread into France and early in the twentieth century it spread to other European countries and America as well. I need not go into the detailed history of the progress of this movement but it is worthwhile to mention that as a result of the discussions held at the Fourth International Congress of Mathematicians at Rome in 1908, a committee known as the "Internationale Mathematische Unterrichts Kommission" (International Commission on the Teaching of Mathematics) was set up with Felix Klein as its Chairman, for the purpose of studying and comparing the tendencies in the teaching of mathematics in various countries and submitting a report to the next meeting of the Congress. A National Committee on Mathematical Requirements was set up in America and their report entitled "The Reorganisation of Mathematics in Secondary Schools" published in 1923 'is generally recognised as a landmark in the history of American mathematical education.' Most nations have had their own national committees and have profited by the study of the reforms proposed and carried out in other countries. In India alone the century-old out-worn programme with hardly any reform is still being followed. Any attempt at reform made by professional mathematicians here and there have been, as I know from personal experience, stubbornly opposed by our educational senators most of whom have no idea of what mathematics is. The following criticism of the guardians of American secondary education made by Dr.

Jesse Newlon at the 1932 Conference on Secondary Education seems to me to be very well applicable to conditions in India even in 1950:

> The American secondary school is a stronghold of conservation where the curriculum is hopelessly traditional and not vitally connected with the needs of youth. The inertia of the secondary school is tremendous. Its teachers and administrators, with few exceptions, are but stereotypes of an outworn concept of education. Every attempt to effect fundamental changes have been stubbornly resisted by a majority of its personnel.

This state of affairs is principally due to the fact that even the educated section of the public, not to speak of the general public, hardly realise that "every major concern among the intellectual concerns of man is", as Professor Keyser[36] puts it, , "a concern of mathematics" and that the study of some advanced mathematics is important not simply because of its utilitarian value in the narrow sense as a master tool for sicentific inventions, but chiefly because in our modern civilisation it has to be regarded as one of the Humanities, the study of which is indispensable for a rational life; for it inculcates the habit of correct thinking and "correct thinking based on true premises secures the mastery of the world"[37]. The world we live in is not static. Change is the great Master that inexorably and pitilessly rules us all and we should not forget that "mathematics consists mainly in the study of functions and the study of functions is the study of the ways in which changes in one or more things produce changes in others"[38].

If all that has been said above be granted, then it is incumbent upon us to formulate a plan of teaching mathematics which will be interesting enough to attract even students of average ability. The present position in schools is however such that the very name of mathematics is a bugbear to even some of the best intellects who shrink from it with a sense of horror and disgust and keep away from it as soon as they have passed the school stage when it is no more a compulsory subject of college studies. Now what should we do to remedy this state of affairs ? I shall mention only some of the things which I think should be done without any delay.

First, a reform of the school curriculum is absolutely necessary. All non-essentials,—and there are quite a lot of them,—should be ruthlessly weeded out and such new matters should be included as would give the young learners a glimpse of the true and beautiful in mathematics and awaken in them a curiosity to learn more of the subject and to dive deep into its pools of everlasting joy and pleasure.

Secondly, the method of teaching mathematics should be revised so as to introduce the aspect of rigour, even at the school stage, wherever possible. I know there are many who will object to the introduction of rigour at this stage but let us see what some great savant have to say about it. Pringsheim[39] says, "I have come to the conclusion that the exertion, without which a knowledge of mathematics cannot be acquired, is not materially increased by logical rigour in the method of instruction". According to D'Alembert[40] "the only way in which to treat the elements of an exact and rigorous science is to apply to them all the rigour and exactness possible. And Hilbert[41], one of the greatest mathematicians of the recent past, declares : "It is an error to believe that rigour in proof is an enemy of simplicity. On the contrary we find it confirmed by numerous examples that the rigorous method is at the same time the simpler and the more easily comprehended". The baneful effect of neglecting rigour where it can be easily applied can hardly be over-emphasised. Loose thinking in the initial stages engenders a habit of mind from which it is difficult to extricate oneself at a later stage when rigorous thinking is indispensable. To quote Whitehead[42]: "When the initial statements are vague and slipshod, at every subsequent stage of thought, common sense has to step in to limit applications and to explain meanings. Now in creative thought common sense is a bad master. It can only act by suppressing originality."

Thirdly, teachers of mathematics should be selected with the utmost care. It should be borne in mind that no teacher can be really effective as a teacher if the range of his knowledge extends only as far as or just beyond the course he has to teach. Not infrequently it happens that a university or college student has to unlearn certain things which he has previously 'learnt', and it is always more difficult to unlearn than to learn. It is not enough that a teacher has been trained in the *methods* of teaching at a teachers' training college which is usually regarded as a sufficient guarantee of his teaching ability . It is good to know the method but what does it avail if he has not acquired mastery over the content? And it is impossible for any one to acquire such mastery unless his knowledge extends well beyond the subject matter of his teaching.

Fourthly, text books, before they are placed in the hands of young learners, should be critically examined as to the statements and proofs given therein even if they are judged to be suitable otherwise. Sometimes for want of a really good text -book it may be necessary to prescribe a badly written book but in all such cases it should be possible for the teacher to point out the defects and to supplement the book by his own teaching.

In what I have stated above I have only tried to emphasise the need for reform and not to give any but a very rough outline of the lines along which reform should be carried out. I have only tried to show that while other nations were awakened by pressing needs long ago, we have all this time been deep in slumber. They have forged ahead and we are lagging miles behind. It is therefore high time that we also exert ourselves in effecting much needed reforms and try to set our house in order. But no effort in this direction can be fruitful unless it is made in an organised manner and is backed by public opinion. It is perhaps pertinent to ask what our national governments, central and provincial, have done in this matter. Perhaps it will be said that the Central Government has not been unmindful of its responsibility and had recently appointed a strong Universities Commission, the report of which has been submitted though not yet published.* While heartily appreciating the laudable desire of the Government for necessary reforms in University education, may I suggest without any disrespect to Government that a Commission of the type appointed by Government can only make recommendations,—perhaps very wise recommendations,—regarding the organisation of education, but they can hardly make any recommendations regarding curricula in general. It seems to me therefore that the report of the Commission will contain hardly anything helpful for the solution of the problems I have been discussing. I suggest that a special committee be set up without delay, with appropriate sub-committees, to go into the question of mathematical studies in our schools, colleges and universities, in view of the fundamental role which mathematics plays in human affairs generally and the sciences in particular. The scientific age is far too advanced to brook any delay in this matter and the sooner it is realised, the better for the country and the nation.

So far I have referred to only one of the factors responsible for the present unsatisfactory state of progress of Mathematics in this country, namely, the lamentable ignorance of the general public about the place of mathematics in modern education and the consequent neglect of school mathematics. There are however various other factors also contributing to this state of affairs. One of these is the fact that the main object for which a university career is sought by the youth in this country, as perhaps elsewhere also, is that of qualifying themselves for fairly lucrative jobs which would enable them to lead a more or less comfortable life. Our best brains are therefore, unfortuntely for our country, attracted to those subjects, which are likely to bring good dividends to the largest number, and mathematics is not one of these dividend-earning subjects. Another reason can perhaps be found in the nature of the question papers in mathematics set for the various competitive examinations conducted by our public service commissions which many of our gifted young men make up their minds to take, even from the beginining of their university career. So far as I know the questions in mathematics usually asked at most of these examinations demand a very highly developed skill in manipulation and the ability to solve most complex and complicated problems like those asked in the old Cambridge Tripos Examinations. It is difficult to understand the object of such a test in mathematics for the recruitment of administrative officers. One should have thought that mainly such questions would be asked as are likely to bring out the real mental faculties of the candidates,—their power of comprehension, logical thinking and lucid exposition,—rather than the ability to solve antiquated problems which is hardly of value in any walk of life. Since mathematics is not a compulsory subject, the candidate who has to offer mathematics as one of the subjects of examination is severely handicapped in comparison with one who can avoid it. This therefore acts as a strong deterrent on even those young men who have a natural inclination for mathematics and diverts them to other courses of study after they pass the school stage to the great detriment of the progress of mathematics in our country. Lastly it seems to me mathematical studies have not so far received sufficient encouragement from Government. Our national Government has planned eleven national laboratories and technological institutions but one sadly misses in the list an Institute for Mathematical Research. Why this omission? Perhaps because mathematics is considered a comparatively unimportant subject whose progress can wait and perhaps it is thought that researches in pure mathematics are little useful as most of them are mere speculations in thought and unrelated to the physical world. Said Voltaire[43]: "In Geometry, as in most sciences, it is very rare that an isolated proposition is of immediate utility. But the theories most powerful in practice are formed of propositions which curiosity alone brought to light and which long remained useless without its being able to divine in what way they should one day cease to be so. In this sense it may be said, that in real science, no theory, no research, is in effect useless." Lessons of history are easily forgotten and it may therefore be worthwhile to remind our countrymen that the study of Conic Sections, originated by Plato, continued to be pursued enthusiastically century after century without any apparent purpose, save perhaps for the enjoyment of the intellectual pleasure that could be derived from a contemplation of those beautiful curves and their remarkable properties. But nearly eighteen centuries afterwards, the genius of Newton was able to produce the fruit of those studies,—perhaps the most wonderful fruit of pure mathematical studies,—in the shape of his famous law of gravitiation the light of which all of a sudden illumined the universe and held out the most efficient instrument for the unravelling of its mysteries. Abstruse mathematical researches should

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* The report was published when this address was in the press.

sent unsatisfactory state of progress of Mathematics in this country, namely, the lamentable ignorance of the general public about the place of mathematics in modern education and the consequent neglect of school mathematics. There are however various other factors also contributing to this state of affairs. One of these is the fact that the main object for which a university career is sought by the youth in this country, as perhaps elsewhere also, is that of qualifying themselves for fairly lucrative jobs which would enable them to lead a more or less comfortable life. Our best brains are therefore, unfortuntely for our country, attracted to those subjects, which are likely to bring good dividends to the largest number, and mathematics is not one of these dividend-earning subjects. Another reason can perhaps be found in the nature of the question papers in mathematics set for the various competitive examinations conducted by our public service commissions which many of our gifted young men make up their minds to take, even from the beginining of their university career. So far as I know the questions in mathematics usually asked at most of these examinations demand a very highly developed skill in manipulation and the ability to solve most complex and complicated problems like those asked in the old Cambridge Tripos Examinations. It is difficult to understand the object of such a test in mathematics for the recruitment of administrative officers. One should have thought that mainly such questions would be asked as are likely to bring out the real mental faculties of the candidates,—their power of comprehension, logical thinking and lucid exposition,—rather than the ability to solve antiquated problems which is hardly of value in any walk of life. Since mathematics is not a compulsory subject, the candidate who has to offer mathematics as one of the subjects of examination is severely handicapped in comparison with one who can avoid it. This therefore acts as a strong deterrent on even those young men who have a natural inclination for mathematics and diverts them to other courses of study after they pass the school stage to the great detriment of the progress of mathematics in our country. Lastly it seems to me mathematical studies have not so far received sufficient encouragement from Government. Our national Government has planned eleven national laboratories and technological institutions but one sadly misses in the list an Institute for Mathematical Research. Why this omission ? Perhaps because mathematics is considered a comparatively unimportant subject whose progress can wait and perhaps it is thought that researches in pure mathematics are little useful as most of them are mere speculations in thought and unrelated to the physical world. Said Voltaire[13] : "In Geometry, as in most sciences, it is very rare that an isolated proposition is of immediate utility. But the theories most powerful in practice are formed of propositions which curiosity alone brought to light and which long remained useless without its being able to divine in what way they should one day cease to be so. In this sense it may be said, that in real science, no theory, no research, is in effect useless." Lessons of history are easily forgotten and it may therefore be worthwhile to remind our countrymen that the study of Conic Sections, originated by Plato, continued to be pursued enthusiastically century after century without any apparent purpose, save perhaps for the enjoyment of the intellectual pleasure that could be derived from a contemplation of those beautiful curves and their remarkable properties. But nearly eighteen centuries afterwards, the genius of Newton was able to produce the fruit of those studies,—perhaps the most wonderful fruit of pure mathematical studies,- in the shape of his famous law of gravitiation the light of which all of a sudden illumined the universe and held out the most efficient instrument for the unravelling of its mysteries. Abstruse mathematical researches should not therefore be neglected or disdained simply because they have no application at the moment. History has shown that there is hardly any branch of abstruse mathematics which has not sooner or later found applications in unexpected and unsuspected manners. The establishment of an Institute of Mathematical Research with necessary equipments and staff can therefore be more than amply justified as a sound investment, and surely our national Government would be well advised to take early steps in the matter.

I have talked long enough without however being able to touch more than a fringe of the problems that face us. I have said practically nothing about higher mathematical studies and research although I wish I had sufficient time at my disposal to be able to do so. My remarks have been mainly directed to the need for placing mathematical education in the secondary schools on a sound basis, for unless we are able to secure a strong foundation and to create a proper attitude towards mathematics, it is idle to expect any improvement in the standard of higher mathematical studies and research; and Free India must, with steadfast zeal and unswerving determination, encourage and promote such research if she is not to slide back into slavery once again. I must, however, now bring this talk to a close and I think I can do it no better than by quoting the following passage[44] which sets forth in beautiful language an appreciation of the nature of mathematics and which I am sure will strike a concordant note in every mathematician's heart:

> Coterminous with space and coeval with time is the Kingdom of Mathematics; within this range her dominion is supreme; otherwise than according to her order nothing can exist; in contradiction to her laws nothing takes place. On her mysterious scroll is to be found written for those who can read it that which has been, that which is, and that which is to come. Everything material which is the subject of knowledge has number, order, or position; and these are her first outlines for a sketch of the Universe. If our feeble hands cannot follow out the details, still her part has been drawn with an unerring pen, and her work cannot be gainsaid. So wide is the range of mathematical sciences, so indefinitely may it extend beyond our actual powers of manipulation that at some moments we are inclined to fall down with even more than reverence before her majestic presence. But so strictly limited are her promises and powers, about so much that we might wish to know does she offer no information whatever, that at other moments we are fain to call her results but a vain thing, and to reject them as a stone where we had asked for bread. If one aspect of the subject encourages our hopes, so does the other tend to chasten our desires, and he is perhaps the wisest, and in the long run the happiest, among his fellows, who has learned not only this science, but also the larger lesson which it directly teaches, namely, to temper our aspirations to that which is possible, to moderate our desires to that which is attainable, to restrict our hopes to that of which accomplishment, if not immediately practicable, is at least distinctly within the range of conception.

REFERENCES

1. Bacon, Francis. *Advancement of Learning*, Bk. 2.
2. Sylvester, J J. *Collected Mathematical Papers*, Vol. 3, p. 424.
3. Russell, Bertrand. *Principles of Mathematics*, p. 1.
4. Howison, G. H. *The Departments of Mathematics and their Mutual Relations. Journal of Speculative Philosophy*, Vol. 5.
5. Klein, Felix. *Anwendung der Differential-und Integralrechnung auf Geometrie*, (1902). p. 26
6. Pringsheim, Alfred. *Jahresberichte der Deutschen Mathematikar Vereinigung* (1904), p. 357.
7. McCormack, T. J. *On the Nature of Scientific Law and Scientific Explanation*, Monist, Vol. 10, p. 555.
8. *Leibnizens Mathematische Schriften*, Book V, p. 307
9. Bernoulli, J. *Opera*, Tome II, pp. 241, 255 and Tome III, p. 174

10. Euler, L. *Introductio in analysin infinitorum,* vol. I, p. 4
11. Dirichlet, G. Lejeune. *Ueber die Darstellung ganz willkürlichen Funktionen durch Sinus-und Cosinusreihen. Werke, Vol*— I, p. 135.
12. Nunn, T. P. *The Teaching of Algebra,*p. 16
13. MacMahon, P. A. *Proceedings of the Royal Society of London* Vol. 63, p.17
14. Hilbert, D. *Mathematical Problems. Bulletin of the American Mathematical Society,* Vol. 8, p. 478.
15. Poincaré, H. *The value of Science, Popular Science Monthly,* 1906, pp. 195-196.
16. Dillmann, C. *Die Mathematic die Fackelträgerin einer neunen Zeit,* p. 5.
17. Pringsheim. A. *Jahresberichte der Deutschen Mathematiker Vereinigung,* Bd. 13, p. 367
18. Macaulay. *Critical and Miscellaneous Essays,* Vol. I, (1879) p. 380
19. *Ibid,* p. 380
20. Poincaré, Henri. *Bulletin of the AmericanMathematical Society,* Vol. 4(1899), p.248
21. *See* p. 160 of the *Eleventh Yearbook of the National Council of Teachers of Mathematics* Columbia University, 1936.
22. *See* Sommerville's *Non-Euclidean Geometry* (1914), pp. 22-23
23. Hill, Thomas. *North American Review,* Vol. 85, pp. 229-230
24. Voltaire, *A Philosophical Dictionary* (1881), Vol. 3, p.40
25. Kummer, E. E. *Berliner Monatsberichte* (1867), p. 395.
26. Russell, Bertrand. *The Study of Mathematics : Philosophical Essays* (1910), p. 73.
27. Hankel, Hermann, *Die Entwickelung der Mathematik in den letzten Jahrhunderten* (1884), p.25.
28. Whitehead, A. N. *Adventures of Ideas,* 1933.
29. Russell, Bertrand. *The ABC of Atoms* (1925), p. 170
30. Russell, Bertrand. *Recent Work on the Principles of Mathematics, International Monthly,* Vol. 4(1901), p. 84
31. Huxley, T. H. *The Scientific Aspects of Positivism, Fortnightly Review* (1898)
32. Hardy, G. H. *A Mathematician's Apology,* (1940), p. 61
33. National Committee on Mathematical Requirements. *The Reorganizantion of Mathematics in Secondary Education,* (1923), p.11.
34. Keyser, C. J. *Lectures on Science, Philosophy and Art* (1908), p. 29.
35. *Unterrichtsblätter fur Mathematik and Naturwissenschaft* (1904), p. 128.
36. Keyser, C. J. *Mole Philosophy and other Eassays,* 1927.
37. Klein, Felix. *Jahresberichte der Deutschen Mathematikar Vereinigung,* Vol. 11, p. 13.
38. Keyser, C. J. *Mole Philosophy and other Essays,* (1927), p. 93, et seq.
39. Pringsheim, Alfred. *Jahresberichte der Deutschen Mathematiker Vereinigung,* (1898), p. 143.
40. *See* De Morgan. *Trigonometry and Double Algebra* (1849), title page.
41. *See Bulletin of the American Mathematical Society,* Vol, 8, p. 441
42. Whitehead, A. N. *Introduction to Mathematics* (1911), p. 157
43. Voltaire. *A philosophical Dictionary* (1881), Vol. I. p. 374.

Spottiswoode, W. *See* Sonnenschein's *Encyclopedia of Education, p.* 208.

The author is greatly indebted, for many of the quotations, to the 'Memorablia Mathematica' by R. E. Moritz, (1914).

SECTION OF STATISTICS

PRESIDENT : P. V. SUKHATME, Ph.D., D.Sc., F.N.I.

Presidential Address

SAMPLE SURVEYS IN AGRICULTURE

1. INTRODUCTION

1.11. I am thankful for being asked to preside over the Section of Statistics of the 37th Session of the Indian Science Congress. Having been in the Indian Council of Agricultural Research for over 10 years, it is natural that I should choose for my address a topic, in the development of which the Council has played a leading role and which has assumed growing importance in recent years. The method of sampling as a means of collecting annual agricultural statistics was almost unknown a decade ago in most provinces in India. Thanks, however, to the pioneering work of Hubback, Mahalanobis, Panse and Kalamkar, rapid and extensive developments in the method have taken place in recent years which have totally changed the situation. The particular development with which the Council is associated is the application of the sampling method to the estimation of crop yields in India. In less than a few years since the Council first initiated a sample survey on crop yields, the method was extended over the major part of India and is now being adopted as a normal routine for the estimation of yields of all principal crops in the country. In several other directions also the Council has helped to develop the uses of sampling for improving agricultural statistics. It will be my object in this address to present to you the principal developments in the field of sampling evolved as a result of this work.

2. ADMINISTRATIVE BACKGROUND

2.11. Sampling practices are influenced by the administrative background and the local conditions as much by the sampling theory itself. The former are often so important that sampling practices select themselves. It is thus necessary to know the administrative background in India for a proper appreciation of the sampling practices developed in recent years for the estimation of crop yields and other agricultural statistics.

2.12. For administrative purposes, the country is divided into 9 provinces, 9 major States and Unions of States and a few minor States and Centrally administered areas. Each province (or State) is further divided into a number of districts, each with a geographical area of about 3 to 4 thousand sq. miles. A district is divided into about 5 tehsils on the average and each of the latter is further divided into 3 to 5 circles for convenience of land revenue administration. A circle contains about 100 villages, each about 1 to 3 sq. miles in area. In Bombay and Madras, the equivalent of a tehsil is a taluka, usually much smaller than a tehsil.

2.13. The village in India is a well defined area with the dwellings clustering together and surrounded by the agricultural land. This land is divided into a number of fields which have been surveyed and mapped and given numbers called survey (khasra) numbers. The average size of a survey number in a province varies from about 0.5 to 6 acres and the average number of survey numbers in a village varies from roughly 300 to 1500 in the different provinces. The conditions in villages are thus totally unlike in U.K. and U.S.A. where a farm is several hundred acres in size and has on it the farmer's home. Again the majority of farmers in India cannot read or write. The communications between villages are also poor.

2.14 For every village or a group of few villages, usually between 2 to 6, there is a village accountant, called Patwari, one of whose major duties is to make a field to field inspection of the area under his jurisdiction and maintain a register showing the survey numbers and the names of the crops grown thereon along with the area under each. There is also a Revenue Inspector in each circle, one of whose duties is to check the registers maintained by the Patwaris in his jurisdiction. It is this feature of field to field enumeration and adequate supervision provided by the Land Records Administration which imparts to the crop acreage figures a high degree of accuracy. This system of recording acreage is naturally not available in the permanently settled areas where no such elaborate agency exists. Of the three provinces under this settlement, however, Bihar and Orissa have taken a commendable step of appointing the requisite agency and the unions of states have also begun taking the necessary steps in this direction.

3. ESTIMATION OF CROP YIELDS

3.1. *The official method*

3.11. The official method of estimating the yield per acre in any year consists in multiplying what is called the normal yield by the condition factor of the crop in that year. The determination of both these factors is, however, largely a matter of guess work under this method. For, the normal yield, which is defined as the yield on average soil in a year of average character, is fixed on the basis of the results of crop cutting experiments carried out in fields which are judged by the experimenters to bear an average crop. No objective procedure is laid down for the choice of the fields and the plots harvested within them. The condition factor is likewise subject to unknown errors, since it is a subjective estimate of the crop in terms of the normal. Usually it is expressed in terms of annas with a fixed number of annas representing the normal. The lower officials make a guess of the condition of the crop in their jurisdiction and pass on the estimates to their immediate superiors. The latter make their own guess at the figures thus reported. The final figure is fixed by the Director of Agriculture or Land Records or by both together with these figures before them. Quite naturally the yield estimates under this procedure are unreliable and have an unknown margin of error.

3.2. *Random Sampling Method*

3.21. That the official method is defective and that the only way of satisfactorily estimating the yield per acre is by conducting crop cutting experiments in randomly selected plots, has been known in India for a long time. To Hubback goes the credit of first employing this principle in practice, in his yield surveys on paddy in 1923-25 (2). Using a triangular wooden frame for marking sample plots with an area of 13.6 sq. ft. in place of 1/10 acre plots used in departmental crop cutting experiments, Hubback carried out a series of experiments on paddy evenly distributed in space and harvesting time and showed that by selecting about 12 centres in a subdivision (tehsil) and harvesting 30 to 40 sample plots on one specified day at each centre the average yield per acre could be estimated with an error of one maund per acre. There was no randomisation, however, in the modern sense of the word in Hubback's method. Sampling at any given centre was limited to those fields where harvesting was in progress on the day the sampler visited the centre. The sample unit was also cut at a short fixed distance from the boundary of the field. Again the small plot size which he adopted for the experiments must have contributed to an appreciable over-estimation of yield. Nevertheless, as an example of a sample survey carried out on statistical basis in the days when the role of randomisation in field designs was just beginning to be known, it was an enterprising piece of work.

3.22. The next advance in the problem of estimation of crop yields by random sample survey came from Mahalanobis (4, 5, 6). He started with an experiment on jute in Bengal in 1939, harvesting plots of various sizes ranging from 5.5 to 66 sq. ft. in 22 randomly selected localities in four districts and gradually extended the survey in the following years to cover all the principal jute growing districts of the province. In 1943-44 he carried out experiments for the estimation of the yield of wheat and gram in Bihar. This was followed by a yield survey on paddy in the same province. A province-wide yield survey on paddy was also carried out in Bengal in 1942-43 and is being continued annually. The main features of his method as gathered from the comprehensive account of the Bihar Crop Survey (5) and other published references are that:

(a) the field work is carried out by ad hoc parties of investigators specially appointed for the purpose;

(b) the sampling is confined to those fields which are ready for harvesting on the date of the investigaror's visit to a place;

(c) sample plots range from 12.5 to 100 sq. ft. and possibly to 200 sq. ft. in size and are marked by portable apparatus specially devised for the purpose; and

(d) the field work is arranged in replicated samples called interpenetrating net work of samples.

An extensive study of the different kinds of errors arising in field work leading to the device of interpenetrating net work of samples and other internal controls, and the explicit formulation of the principle of maximising precision for a given cost in its application to the problem of agricultural surveys, in terms of the cost and the variance functions are the principal contributions of Mahalanobis.

3.23. The next important advance came from Panse and Kalamkar (14, 15, 16). Finding that in spite of the admittedly defective nature of official yield statistics, random sampling method had not been taken up by the provinces, they brought an altogether different approach on the problem. They argued that if an objective method of crop estimation was to be successfully introduced in India as an annual feature, the method should be developed in such a manner that it would fit into the existing administrative machinery with the minimum essential changes in the current procedure, and its permanent adoption would not necessitate any heavy additional expenditure. The problem, as they viewed, therefore, was not one of starting any elaborate research on the principles and practice of random sampling but of demonstrating in the first instance to the provincial administrators the practicability, efficiency and economy of the method. The adoption of randomly selected fields for crop cutting experiments was to them a question of convincing the provincial governments that the replacement of the present personal selection of fields by random sampling was both essential and practicable. The number of crop cutting experiments to be carried out and their distribution as also the size of sampling units, however, required to be determined by experimentation.

3.24. The first random sample survey in the temporarily settled provinces to be undertaken with these objectives in view was carried out on cotton in Akola district of the C. P. and Berar (14). The results of this survey showed that the frame work of the Revenue Administration in the temporarily settled provinces lent itself excellently to the application of random sampling method for the estimation of crop yields. Tehsils which form relatively homogeneous and compact divisions of the district were chosen as the strata; within a tehsil a village was chosen as a unit of sampling; within a village a field was the sub-unit and within a field a plot of 1/10th of an acre was the ultimate unit of sampling. The conclusion of the survey was that by sampling about 70 villages distributed in proportion to the area under cotton in the different tehsils by sampling 3 to 4 fields in each selected village and by harvesting 1/10th of an acre plot in each selected field, the yield for a district can be estimated with a sampling error approaching 5%. The survey was extended to two districts in 1943-44 and to the whole cotton tract in 1944-45 and is since carried out annually. The principal modification in the original design in extending the survey to provincewide scale as an annual feature was the use of revenue inspector's circles as the strata in place of tehsils. This change was made principally on the ground of administrative convenience to ensure even distribution of work among the Revenue Inspectors to whom the work was entrusted. The number of villages allocated varied from 55 to 65 in the principal cotton growing districts and from 30 to 33 in the remaining districts. The yield estimates of principal districts are determined with sampling errors ranging from 5 to 7% and those for the province with error approaching 2%.

3.3 *Surveys by the Indian Council of gricultural Research*

3.31. The first surveys on cereals on full provincial scale using the method based on these results were carried out in 1943-44 in the Punjab, U.P. and Orissa. This was the beginning of the rapid and extensive adoption of the random sampling method all over the country. By 1945, the surveys were extended to cover the principal wheat belt comprising the Punjab, Sind, NWFP, U.P. and C.P. and Berar and in the following year to cover the principal paddy belt comprising Madras, Bombay, C.P., U.P., Bihar and Orissa. The principal development of these surveys was the appointment of full-fledged agricultural statisticians in the provinces to take over this work as an annual feature in place of the current procedure of crop estimation. These appointments in their turn led to a further extension of the scope of these surveys to cover more and more crops. In Bombay Province, crop cutting experiments by the random sampling method are carried out as an annual feature on as many as six crops, wheat, paddy, Jowar (khariff), jowar (rabi), bajra, cotton and pilot surveys are in progress on maize, kodra, tobacco, groundnut, ragi and gram, for investigating the possibility of extending these on a full provincial scale. In the C.P. and Berar, the crops included are wheat, paddy, jowar and cotton. In Bihar experiments are in progress on wheat, paddy, gram, arhar and masur. And appropriately enough, with the renewed drive for increased production of food grain crops and the consequent need for accurately knowing the production of food grains, the Government of India have given a further impetus by approving a five-year scheme for the extension of these experiments to all principal crops in the country including States and State Unions.

3.32. The design adopted in these surveys is stratified multi-stage random sampling. The talukas or the Revenue Inspector's circles into which a district is divided constitute the strata. From each of these a certain number of villages are randomly selected approximately in proportion to the area under the crop in the stratum. In each selected village, three fields (sometimes two) are selected at random out of all the fields sown with the crop and in each selected field a plot of the size usually adopted in official crop cutting experiments is located at random. The final experiment consists in harvesting the crop from the plots so marked and threshing, winnowing and weighing the produce thereform immediately afterwards. Yield of grain from one experimental plot constitutes a single observation for the sample. Allowance for the moisture contained in the produce at the harvesting stage is made on the basis of special experiments conducted for the purpose on a sub-sample of the observations. The experiments are carried out and supervised by the provincial staff of the Departments of Agriculture and/or Revenue. Training classes are conducted annually for the field staff. in order to ensure efficient work. The experiments are also supervised periodically by the statistical staff at the provincial headquarters and the Centre. In the five-year scheme additional supervision from the Centre based on the principle of random sampling has been provided.

3.33. The sampling fraction adopted in the surveys varies from five parts in a million to twenty, the variation among other things being brought about by limitations of the staff available in the various strata. The precision attained in the surveys in the various provinces has naturally depended upon the size of the sample but has been on the whole highly satisfactory. For the major districts the yield estimates have been determined with a sampling error approaching 6 or 7% while those for the province as a whole with errors varying from 1 to 4 percent. Before passing on to the other uses of sampling in agricultural statistics, we shall in what follows examine the efficiency of the various technical and organisational aspects of the design so successfully adopted in the yield surveys. We shall, however confine the discussion, owing to the limitation of space, to only the more important features of the design.

3.4 *Estimation of the Mean and its Sampling Error*

3.41.· Suppose the population is made up of t strata and we sample n_j units from the j^{th} stratum and further sample m_{jk} sub-units from each of the selected units in the j^{th} stratum.

Let

x_{jkl}	be the value of the character for the l^{th} sub-unit of the k^{th} unit of the j^{th} stratum
$\bar{x}_{jk\cdot}$	the true mean of the k^{th} unit of the j^{th} stratum,
$\bar{x}_{jk(m_{jk})}$	the corresponding sample mean, so that

$$\bar{x}_{jk(m_{jk})} = \frac{1}{m_{jk}} \sum_{l=1}^{m_{jk}} x_{jkl}$$

$\bar{x}_{j..}$ the true mean of the j^{th} stratum,

$\bar{x}_{j(n_j, m_{jk})}$ the corresponding sample mean, so that

$$\bar{x}_{j(n_j,m_{jk})} = \frac{1}{n_j} \sum_{k=1}^{n_j} \bar{x}_{jk(m_{jk})}$$

$\bar{x}_{...}$ the population mean, and

$\bar{x}_{(t,n_j,m_{jk})}$ the corresponding sample estimate, so that

$$\bar{x}_{(t,n_j,m_{jk})} = \sum_{j=1}^{t} W_j \, \bar{x}_{j(n_j,m_{jk})}$$

where W_j is proportional to the size of the j^{th} stratum.

3.42. It is known that when the number of sub-units sampled from each selected unit is constant, say m, the variance of the sample mean is given by

$$V(\bar{x}_{nm}) = \sum_{j=1}^{t} \frac{W_j^2}{n_j}\left(\sigma^2_{(sv)j} + \frac{\sigma^2_{(vf)j}}{m}\right) \tag{1}$$

where $\sigma^2_{(sv)j}$ and $\sigma^2_{(vf)j}$ denote the true variances between units (villages) and between sub-units (fields) within units in the j^{th} stratum, the suffixes *s*, *v* and *f* standing for the stratum, village and field respectively. For a finite population of N units with N_j units in the j^{th} stratum and M_j sub-units in each unit, the variance is given by

$$V(\bar{x}_{nm}) = \sum_{j=1}^{t} \sigma^2_{(sv)j} W_j^2 \left(\frac{1}{n} - \frac{1}{N}\right) + \sum_{j=1}^{t} \sigma^2_{(vf)j} \, W_j^2 \left(\frac{1}{n_j m} - \frac{1}{N_j M_j}\right) \tag{2}$$

where $M_j\sigma^2_{(sv)j} + \sigma^2_{(vf)j}$ and $\sigma^2_{(vf)j}$ are now defined as the population mean squares between units (villages) and between sub-units within units (fields within villages) in the j^{th} stratum given by

$$M_j\sigma^2_{(sv)j} + \sigma^2_{(vf)j} = \frac{M_j \sum_{k=1}^{N_j} (\bar{x}_{jk.} - \bar{x}_{j..})^2}{N_j - 1} \tag{3}$$

$$\sigma^2_{(vf)j} = \frac{\sum_{k=1}^{N_j} \sum_{l=1}^{M_j} (x_{jkl} - \bar{x}_{jk.})^2}{N_j (M_j - 1)} \tag{4}$$

In crop surveys where W_j would appropriately denote the proportion of the area under the crop in the j^{th} stratum and where the number of fields M_j is large as compared with the number sampled from a village, equation (2) will be

$$V(\bar{x}_{nm}) = \sum_{j=1}^{t} \sigma^2_{(sv)j} W_j^2 \left(\frac{1}{n_j} - \frac{1}{N_j} \right) + \sum_{j=1}^{t} \sigma^2_{(vf)j} W_j^2 \frac{1}{n_j m} \tag{5}$$

the estimates of $\sigma^2_{(sv)j}$ and $\sigma^2_{(vf)j}$ being provided by

$$\sigma^2_{(sv)j} = \frac{S^2_{(sv)j} - S^2_{(vf)j}}{m} \tag{6}$$

and

$$\hat{\sigma}^2_{(vf)j} = S^2_{(vf)j} \tag{7}$$

$S^2_{(sv)j}$ and $S^2_{(vf)j}$ denoting the mean squares between villages and between fields within villages in the analysis of the variance of the sample plots.

3.43. Although it is usually provided that the number of sub-units to be sampled from each selected unit should be constant, this is not always practicable particularly in yield surveys. The form of the best unbiased linear estimate of the true mean for a stratum is not apparent in this case. The weighted mean is given by

$$\frac{\sum_{k=1}^{n_j} m_{jk} \bar{x}_{jk(m_{jk})}}{\sum_{k=1}^{n_j} m_{jk}}.$$

as also the unweighted mean $\frac{1}{n_j} \sum_{k=1}^{n_j} \bar{x}_{jk(m_{jk})}$ provide unbiased estimates of $\bar{x}_{j..}$

but it will be presently shown that their relative efficiency depends on the relative magnitude of the true variances between and within units. For it is easy to see that whereas the sampling variance of the weighted mean is given by

$$\sigma^2_{(sv)j} \frac{\sum_{k=1}^{n_j} m_{jk}^2}{m_0^2} + \frac{\sigma^2_{(vf)j}}{m_0} \tag{8}$$

where

$$m_0 = \sum_{k=1}^{n_j} m_{jk}$$

that of the unweighted mean is

$$\frac{\sigma^2_{(sv)j}}{n_j} + \frac{\sigma^2_{(vf)j}}{n_j^2} \sum_{k=1}^{n_j} \frac{1}{m_{jk}} \tag{9}$$

The differenc between (8) and (9) is not always of the same sign. In fact the unweighted mean will be a more efficient estimate than the weighted mean if

$$\frac{\sigma^2_{(sv)j}}{\sigma^2_{(vf)j}} \geqslant \frac{\dfrac{\sum\limits_{k=1}^{n_j} \dfrac{1}{m_{jk}}}{n_j^2} - \dfrac{1}{m_0}}{\dfrac{\sum\limits_{k=1}^{n_j} m_{jk}}{m_0^2} - \dfrac{1}{n_j}}$$

This inequality can be written as

$$\frac{\sigma^2_{(sv)j}}{\sigma^2_{(vf)j}} \geqslant \frac{\bar{a}_j\left(\dfrac{\bar{a}_j}{\bar{h}_j} - 1\right)}{s_j^2}$$

where $\bar{a}_j$ and $\bar{h}_j$ are the arithmetic and harmonic means and s_j^2 the variance of m_{jk}'s. If the deviations of m_{jk}'s from their mean are small the inequality can be written as simply

$$\frac{\sigma^2_{(vf)j}}{\sigma^2_{(sv)j}} \leqslant \bar{a}_j \tag{10}$$

In yield surveys the true variance between fields within villages is about twice the true variance between villages, so that the unweighted mean can be taken to be the more efficient estimate than the weighted mean whenever the number of fields sampled per village is three or more. On the other hand when the number of fields sampled from a village is two or less, the weighted mean must be considered to be the more efficient of the two. It can be shown that the above result is independent of the finite size of the population (26).

As to the sample estimates of $\sigma^2_{(vf)j}$ and $\sigma^2_{(sv)j}$ when m is not constant from unit to unit, it can be shown that the best estimate of $\sigma^2_{(vf)j}$ is still provided by the mean square between fields within villages in the sample but that of $\sigma^2_{(sv)j}$ is now given by

$$\hat{\sigma}^2_{(sv)j} = \frac{S^2_{(sv)j} - S^2_{(vf)j}}{\bar{m}_j}$$

where

$$\bar{m}_j = \frac{1}{n_j - 1}\left\{ \sum_{k=1}^{n_j} m_{jk} - \frac{\sum\limits_{k=1}^{n_j} m_{jk}^2}{\sum\limits_{k=1}^{n_j} m_{jk}} \right\} \tag{11}$$

m_{jk} ($k=1, 2, \ldots n_j$) denoting the number of fields sampled in the k^{th} sampled village of the j^{th} stratum. A pooled estimate of $\sigma^2_{(sv)}$ for the population will be given by

$$\hat{\sigma}^2_{(sv)} = \frac{S^2_{(sv)} - S^2_{(vf)}}{\bar{m}} \qquad (12)$$

where $\bar{m} = \dfrac{\sum\limits_{j=1}^{t} (n_j - 1)\, \bar{m}_j}{n-1}$ and $S^2_{(sv)}$ and $S^2_{(vf)}$ denote the pooled mean square in the samples.

3.44. The application of these formulæ to yield surveys implies that every plot in a stratum gets an equal chance of being included in the sample. Actually the units and sub-units being of unequal size, smaller villages and smaller fields get a relatively larger chance of selection per unit area under the crop. There is thus a possibility that the yield estimate may be biased if the yield per acre is associated with the size of village (or field). One can, however, correct for this bias either by selecting units and sub-units with probabilities proportional to their size or by weighting plot yields with the corresponding area of fields in a village and weighting the village means by the corresponding areas under the crop. The results of crop surveys, however, show that errors likely to be produced from this source of bias are trivial and call for no correction in practice. The table reproduced below is typical of these results and show that the errors from this source are negligible as compared with the district sampling errors which as stated earlier vary from 5 to 7 percent for major districts.(20)

TABLE I

WHEAT SURVEY—EAST PUNJAB, 1943-44.

District	Yield in maunds per acre	
	Uncorrected	Corrected
1. Amritsar	12.50	12.65
2. Gurdaspur	10.07	10.47
3. Jullunder	10.20	10.71
4. Hoshiarpur	9.77	9.67
5. Ludhiana	15.16	15.14
6. Ferozepur	12.78	13.00
7. Ambala	10.38	9.96
8. Karnal	10.20	10.55
9. Hissar	13.25	13.88
10. Rohtak	12.20	13.12
11. Gurgaon	9.31	9.14
12. PROVINCE	11.18	11.26

3.45. Similarly in locating a plot at random within a field, the central portion of the selected field will be relatively over-sampled as compared with the surrounding area and may give rise to bias if the yield is correlated with the position of the plot in the field. One can correct for this sampling bias too by means of suitable correction factors evolved for the purpose but the results of crop-surveys have again shown that the errors likely to be produced from this source are trivial. The possible influence of this source of bias can be examined in other ways also such as by tabulating the frequency distribution of the plot yields according to the relative position of the plots in the field. The table given below is typical of the results of crop surveys; column 1 shows the relative position of the plot defined by the quotient of the random number of the starting point of the plot by the length of the field minus the length of the plot ; column 2 shows the number of plots having the relative position as defined in column 1 and column 3 shows the average yield per plot, columns 4 and 5 give the same figures when the relative position is defined along the breadth of the field. It will be seen that there is hardly any association between the average yield and the relative position of the plot in the field which can produce errors comparable with sampling errors. Incidentally the distribution of number of plots shows that the location of the starting point of the plot was genuinely random as expected.

TABLE 2

PADDY SURVEY—MADRAS, 1946-47.

Relative position of the plot	Length		Breadth	
	No. of plots.	Av. yield in oz/plot.	No. of plots.	Av. yield in oz/plot.
0–.1	215	248.8	249	243.7
.1–.2	220	249.4	227	242.2
.2–.3	197	248 6	214	237.0
.3–.4	213	233.5	199	262.6
.4–.5	238	253.7	234	233.2
.5–.6	207	260.4	198	253.1
.6–.7	192	247.5	178	267.6
.7–.8	208	254.9	199	245.3
.8–.9	185	234.2	196	261.1
.9–1.0.. ..	201	253.4	182	248.4
Total ..	2,076	248.6	2,076	248.6

3.5. *Allocation of Sampling Units between and within Strata*

3.51. The formulæ given in the previous section have to be supplemented by considerations of cost before using them for obtaining guidance in the optimum allocation of sampling units. When experiments are carried out by the departmental staff in the course of their normal duties, each member of the staff working within his own jurisdiction, the principal item of cost will usually be on labour for harvesting, threshing and cleaning of produce. The expenditure on travelling between villages within circles will usually be negligible under these conditions. Whatever travelling is required, is undertaken as part of the normal touring of the field staff, who are expected to tour about three weeks in a month and cannot possibly undertake more touring merely because additional funds are made available. Equally, the expenditure on statistical analysis connot be charged to the cost of a specific survey when the departmental statistician is available to carry it out as part of his normal functions. At best the expenditure on travelling for supervision incurred by the statistical staff can be charged to the survey but this will usually be small as compared with the expenditure on labour for processing of produce. The contingent expenditure for the survey such as stationery, stamps etc. will vary with the number of experiments. The major part of the total expenditure on a survey when it is planned as an annual feature and carried out by the local departmental staff in the course of their duties will, therefore, roughly vary with the total number of experiments planned as may be seen from the following typical budget for Central Provinces for paddy during 1949-50.

		Rs.
1.	Labour charges for harvesting etc. @ Rs. 2/- per plot (1232 plots)	2464
2.	Stationery, stamps and other contingencies	500
3.	Provision for replacement charges of experimental equipment	500
	Total estimated expenditure	Rs. 3464

Without, therefore, significantly increasing the sampling error by departing from the optimum values, the problem of optimim allocation between strata can be considered as the problem of minimising the sampling variance for a fixed total number of sampling units. Necessarily the principle of minimising the sampling variance for a given number of sampling units will be applied separately to each district because the districts will also be important though subsidiary domains of study.

3.52. The sampling variance of a district mean yield will be given by

$$\sum_{j=1}^{t} \sigma^2_{(sv)j} \frac{A_j^2}{A^2} \left(\frac{1}{n_j} - \frac{1}{N_j} \right) + \sum_{j=1}^{t} \sigma^2_{(vf)j} \frac{A_j^2}{A^2} \frac{1}{n_j m}$$

For a given number of sampling units for the district this is minimised when

$$n_j \propto A_j \sqrt{\sigma^2_{(sv)j} + \frac{\sigma^2_{(vf)j}}{m}} \qquad (13)$$

In general, estimates of $\sigma^2_{(sv)j}$ and $\sigma^2_{(vf)j}$ based on even a moderately small sample will improve the allocation (19) but for a stratum of the size of a Revenue Inspector's circle containing hardly 2 to 4 villages in the sample the values will not be sufficiently accurately known. The results of crop surveys show that these values will usually not differ significantly for different strata *within* a district. The distribution of units among the different strata within a district directly in proportion to the area under the crop in the strata and subject to the condition of being whole numbers should, therefore, give a sufficiently good allocation without significantly increasing the cost of the survey or the sampling error of the estimated mean. It is worth noting that the optimum allocation of the sample is independent of N_j.

3.53. The distribution of experiments between villages, fields and plots of a stratum similarly calls for making effective use of the available resources. Clearly the estimated yield for a stratum will have maximum precision when experiments are distributed at the rate of one per village. Equally there are other considerations which counsel reduction in the number of villages by increasing the number of experiments within a village. The foremost of these arises from the need to ensure that the visit of the field staff to a village selected for experiments is fully utilised. The limited period available for harvesting, the poor communications between villages and the fact that the field staff have to do the work in the course of their normal duties all suggest the need for restricting the number of villages by increasing the number of experiments within each. The extent to which the number of experiments within a village can be profitably increased at the expense of the number of villages is seen from the following table showing the number of villages required for a given number of fields per village and plots per field for estimating the mean yield of irrigated wheat with 5 per cent sampling error. Since the results relate to the sampling of irrigated wheat only, they cannot be considered as typical of the crop surveys but they serve well to illustrate the principle under consideration.

TABLE 3

WHEAT SURVEY IN MORADABAD DISTRICT, U.P. 1944-45.
(plot size 1/92th acre)

No. of plots per field. / No. of fields per village	1	2	3	4
	Number of villages.			
1	88	74	70	68
2	63	56	54	52
3	54	50	48	47
4	50	46	45	45
5	47	45	44	43
6	46	43	43	42

It will be seen that while the number of villages decreases rather considerably as the number of fields is increased from one to two, there is not any appreciable decrease in the number of villages with further increase in the number of fields. The increase in the number of plots per field has hardly any effect on the number of villages. These results suggest that two fields per village with one plot per field is about the optimum distribution within a stratum.

3.6 *Stratification*

3.61. For province-wide yield surveys, with districts as domains of study, which are to be carried out annually, the method of stratification has to be both administratively convenient and statistically efficient. The former requirement leads to the choice of the revenue inspectors' circles (or talukas) as the strata. In this section we shall examine their efficiency in terms of the relative magnitude of the variances of the district estimate(a) with revenue inspectors' circles (or talukas) as the strata and (b) without strata.

3.62. An examination of the equation (1) for the variance of the mean in a sub-sampling design will show that for estimating the variance (b) all that is needed is an estimate of the quantity σ^2_{dv} representing the true variance between villages within district. It follows that the gain due to stratification for any district is simply the percentage increase of the variance given by

$$V\{\bar{x}_{(nm)}\} = \frac{\sigma^2_{dv}}{n} + \frac{\sigma^2_{vf}}{nm} \tag{14}$$

over the variance given by (1). The effect of varying the numbers of villages and fields per village on the gains due to stratification is also easily calculated by substituting in these formulæ the desired values of n and m. Since $\sigma^2_{(vf)j}$ and $\sigma^2_{(sv)j}$ can be estimated from (6) and (7) the problem thus reduces to the estimation of σ^2_{dv} defined by

$$\sigma^2_{dv} = E\,(\bar{x}_{jk\cdot} - \bar{x}_{\dots})^2 \tag{15}$$

We shall express the difference $\bar{x}_{jk} - \bar{x}_{\dots}$ as

$$\bar{x}_{jk\cdot} - \bar{x}_{\dots} = \bar{x}_{jk\cdot} - \bar{x}_{j\cdot\cdot} + \bar{x}_{j\cdot\cdot} - \bar{x}_{\dots} \tag{16}$$

Squaring and taking expectations, we have

$$E\,(\bar{x}_{jk\cdot} - \bar{x}_{\dots})^2 = \sum_{j=1}^{t} W_j \sigma^2_{(sv)j} + \sum_{j=1}^{t} W_j\,\bar{x}^2_{j\cdot\cdot} - \bar{x}^2_{\dots} \tag{17}$$

Let

$$\left.\begin{aligned} x_{jkl} - \bar{x}_{jk\cdot} &= e_{jkl} \\ \bar{x}_{jk\cdot} - \bar{x}_{j\cdot\cdot} &= \bar{\varepsilon}_{jk\cdot} \\ \text{and}\qquad \frac{1}{n_j}\sum_{k=1}^{n_j} \bar{\varepsilon}_{jk\cdot} &= \bar{\varepsilon}_{j(n_j)\cdot} \end{aligned}\right\} \tag{18}$$

so that

$$\frac{1}{n_j}\sum_{k=1}^{n_j} \bar{x}_{jk\cdot} = \bar{\varepsilon}_{j(n_j)\cdot} + \bar{x}_{j\cdot\cdot} \tag{19}$$

Squaring and taking the expected values in (19) and remembering that

$$E\,(\bar{\varepsilon}^2_{j(n_j)\cdot}) = \frac{\sigma^2_{(sv)j}}{n_j}, \tag{20}$$

we have

$$E\left\{\sum_{j=1}^{t} W_j \bar{x}^2_{j(n_j)\cdot}\right\} = \sum_{j=1}^{t} W_j \bar{x}^2_{j\cdot\cdot} + \sum_{j=1}^{t} \frac{W_j}{n_j}\,\sigma^2_{(sv)j} \tag{21}$$

From (19) we also have

$$\sum_{j=1}^{t} W_j\,\bar{x}_{j(n_j)\cdot} = \sum_{j=1}^{t} W_j\,\bar{\varepsilon}_{j(n_j)\cdot} + \sum_{j=1}^{t} W_j\,\bar{x}_{j\cdot\cdot}$$

whence, squaring and taking expected values on both sides and denoting $\sum_{j=1}^{t} W_j \bar{x}_{j(n_j)\cdot}$ by $\bar{x}_{(n)\cdot}$ and $\sum_{j=1}^{t} W_j \bar{x}_{j\cdot\cdot}$ by $\bar{x}_{\cdot\cdot\cdot}$

$$E\left\{\bar{x}^2_{(n)\cdot}\right\} = \sum_{j=1}^{t} \frac{W_j^2}{n_j}\,\sigma^2_{(sv)j} + \bar{x}^2_{\cdot\cdot\cdot} \tag{22}$$

From (21) and (22) we obtain

$$\sum_{j=1}^{t} W_j \bar{x}_j^2{}_{\cdot\cdot} - \bar{x}^2_{\cdot\cdot\cdot} = E\left\{\sum_{j=1}^{t} W_j \bar{x}_j{}^2_{(n_j)\cdot} - \bar{x}^2_{(n)\cdot}\right\} - \sum_{j=1}^{t} \frac{W_j}{n_j}\,\sigma^2_{(sv)j}$$

$$+ \sum_{j=1}^{t} \frac{W_j^2}{n_j}\,\sigma^2_{(sv)j} \tag{23}$$

Substituting in (17), we have

$$\sigma^2_{dv} = \sum_{j=1}^{t} \left\{W_j - \frac{W_j}{n_j} + \frac{W_j^2}{n_j}\right\} \sigma^2_{(sv)j} + E\left\{\sum_{j=1}^{t} W_j \bar{x}_j{}^2_{(n_j)} - \bar{x}^2_{(n)\cdot}\right\} \tag{24}$$

Now taking the mean over m_{jk} fields in the k^{th} village of the j^{th} stratum in equation (1) in (18), we have

$$\bar{x}_{jk(m_{jk})} = \bar{\varepsilon}_{jk(m_{jk})} + \bar{x}_{jk\cdot} \tag{25}$$

Summing (25) over a given n_j villages in the j^{th} stratum and taking the mean we get

$$\bar{x}_{j(n_j m_{jk})} = \frac{1}{n_j}\sum_{k=1}^{t} \bar{\varepsilon}_{jk(m_{jk})} + \bar{x}_{j(n_j)\cdot} \tag{26}$$

Whence, squaring and taking expectations on both sides, multiplying by W_j and summing over all the t strata we have

$$\sum_{j=1}^{t} W_j \bar{x}^2_{j(n_j)\cdot} = E\left\{\sum_{j=1}^{t} W_j \bar{x}^2_{j(n_j, m_{jk})}\right\} - \sum_{k=1}^{n_j} \frac{W_j}{n_j \bar{h}_j}\,\sigma^2_{(vf)j} \tag{27}$$

where $\bar{h}_j$ is the harmonic mean of m_{jk}'s.
From (26) we also obtain

$$\sum_{j=1}^{t} W_j \bar{x}_{j(n_j, m_{jk})} = \sum_{k=1}^{n_j} W_j \bar{\varepsilon}_{j(n_j, m_{jk})} + \sum_{j=1}^{t} W_j \bar{x}_{j(n_j)\cdot}$$

or

$$\bar{x}_{(t, n_j, m_{jk})} = \sum_{j=1}^{t} W_j \bar{\varepsilon}_{j(n_j, m_{jk})} + \bar{x}_{(n)\cdot} \tag{28}$$

Squaring and taking expectations for a fixed n

$$\bar{x}^2_{(n)\cdot} = E\left\{\bar{x}^2_{(t,n_j,m_{jk})}\right\} - \sum_{j=1}^{t}\frac{W_j^2}{n_j}\frac{\sigma^2_{(vf)j}}{\bar{h}_j} \tag{29}$$

From (27) and (29) we have

$$\sum_{j=1}^{t} W_j\bar{x}^2_{j(n_j)\cdot} - \bar{x}^2_{n\cdot} = E\left\{\sum_{j=1}^{t} W_j\,\bar{x}^2_{(n_j,m_{jk})} - \bar{x}^2_{(t,n_j,m_{jk})}\right\} - \sum_{j=1}^{t}\frac{W_j}{n_j\bar{h}_j}\,\sigma^2_{(vf)j}$$

$$+\sum_{j=1}^{t}\frac{W^2{}_j\sigma^2_{(vf)j}}{n_j\;\bar{h}_j} \tag{30}$$

Substituting the result from (30) in (24) we have

$$\hat{\sigma}^2_{dv} = \sum_{j=1}^{t}\left(W_j - \frac{W_j}{n_j} + \frac{W_j^2}{n_j}\right)\sigma^2_{(sv)j} - \sum_{j=1}^{t}\left(\frac{W_j}{n_j\;\;j} - \frac{W_j^2}{n_j\,h_j}\right)\sigma^2_{(vf)j}$$

$$+\sum_{j=1}^{t} W_j\,\bar{x}_j^2{}_{(n_j,\,m_{jk})} - \bar{x}^{2'}_{(t,\,n_j,\,m_{jk})} \tag{31}$$

Whence on substituting in (14), we obtain an estimate of the variance of the district mean appropriate for the method of sampling villages directly from the district without stratification. On pooling the results for the distritcs we get the gain in precision resulting from stratification for the province as a whole.

3.63. Results given below are typical of the gains in precision resulting from stratification. Row 1 of the table 4 gives the sampling variance of the observed mean, row 2 gives the estimated variance of the mean if villages had been selected directly from each district i.e. without strata within dis-

TABLE 4

PADDY SURVEY IN MADRAS, 1946-47, 1947-48

FIRST CROP

Variance	1946-47			1947-48		
	No. of fields			No. of fields		
	2	3	4	2	3	4
1) Talukas as strata (actual)	27.6	24.0	22.2	32.7	27.4	24.7
2) Districts as strata	31.5	28.1	26.4	47.7	42.7	40.2
3) % gain	14.0	17.1	19.1	45.8	56.2	63.0
4) Talukas as strata ($n_j \propto A_j$ within districts)	25.5	22.1	20.4	30.4	25.4	22.9
5) % gain	23.4	27.0	29.2	56.9	68.0	75.4

SECOND CROP

Variance	1946-47			1947-48		
	2	3	4	2	3	4
1) Talukas as strata (actual)	28.8	24.9	22.9	59.6	53.2	50.1
2) Districts as strata	34.2	30.8	29.1	70.3	64.8	62.1
3) % gain	18.6	23.6	26.7	18.0	21.8	24.0
4) Talukas as strata $n_j \propto A_j$ within districts	25.0	21.6	19.9	51.6	46.1	43.4
5) % gain	36.8	42.5	46.2	36.3	40.6	43.1

tricts, row 3 gives the percentage gain in precision, row 4 gives the estimated variance had villages been distributed in proportion to the area under paddy in each taluka of the district and row 5 the corresponding gain in precision. The effect of varying m is also brought out in the table. The table shows that while the gains actually made are of the order of 20% (except in one season when it reaches over 40%) there is considerable scope for further increasing these gains by distributing villages in proportion to the acreage under paddy in the different strata.

Studies undertaken on the relative efficiency of revenue inspectors' circles and tehsils as the strata show that the precision is improved by using circles in place of taluka as the strata but the gain is not appreciable.

3.64 The formulæ derived above are general formulae for estimating gains due to stratification in a sub-sampling design. Two particular cases of the formulae are worth noting :

(*a*) *No sub-sampling*

The appropriate expression for $\hat{\sigma}^2_{dv}$ on a unit basis is derived from (31) by replacing $\bar{h}_j$ by unity. This is the expression given by Yates (28).

(*b*) *Sub-sampling when* $m_{jk}=m$, $n_j \propto W_j$, $\sigma^2_{(sv)j}=\sigma^2_{(sv)}$ and $\sigma^2_{(vf)j}=\sigma^2_{(vf)}$

Then $$\hat{\sigma}^2_{dv} = \hat{\sigma}^2_{sv} + \frac{t-1}{t}\hat{\sigma}^2_{ds}$$

so that the gain in precision when m fields are sampled per village is simply

$$\frac{t-1}{t}\hat{\sigma}^2_{ds}\Bigg/\hat{\sigma}^2_{sv} + \frac{\hat{\sigma}^2_{vf}}{m}$$

This expression was first given by Cochran (1) and usually overestimates gains due to stratification. The exact expression of $\hat{\sigma}^2_{dv}$ when N_j is finite is slightly different from that in (31) and is given elsewhere by the author (26).

3.7 *Size of Sampling unit*

3.71. As mentioned earlier, the choice of sampling units whether in the first, second or ultimate stages of sampling has to be made on grounds of both administrative convenience and statistical efficiency. The former consideration requires that the sampling units should be natural units or natural groups of such units. The possible alternatives in the first stage of sampling are, therefore, a village and a patwari circle. A field is the natural choice in the second stage of sampling, while within a field the unit has to be necessarily an artificial one but even here, as will be presently shown, there is an advantage in continuing the current official plot size.

3.72. The relative efficiency of using a village and patwari circle as the units of sampling in the first stage with a field (or plot) as the sub-unit can be readily determined by the approach indicated in the previous section. For it is easy to see that the variance of the sample mean based on n' patwari circles and m' fields is given by

$$\sigma^2_{sc}\left(\frac{1}{n'} - \frac{1}{N'}\right) + \sigma^2_{cf}\left(\frac{1}{n'm'}\right) \qquad (33)$$

while that based on n' villages and m' fields by

$$\sigma^2_{sv}\left(\frac{1}{n'}-\frac{1}{N}\right)+\sigma^2_{vf}\,\frac{1}{n'\,m'} \qquad (34)$$

N′ and N denoting the numbers of patwari circles and villages in the stratum. The gain in precision using a patwari circle as unit in place of village is, therefore, given by the ratio of (34) to (33).

3.73. Results of the yield surveys carried out in small tracts like Delhi Province with patwari circles as the strata and a village, field and plot as the successive units of sampling within patwari circles enable us to judge the relative efficiency of a patwari circle and village as units of sampling in large-scale yield surveys. These are set out in the table below for $n'=5,10,20$ and $m'=2$. It will be seen from the table that the gain in precision resulting from the use of patwari circle as a unit of sampling increases as n' increases being about 20% when $n'=5$, which is about the number usually selected per stratum in large scale yield surveys. Whether this gain will compensate the additional labour involved in sampling fields directly from the circles is a question which deserves to be studied further.

TABLE 5

Wheat Survey—Delhi Province, 1946–49

	1946-47			1947-48			1948-49		
n'	5	10	20	5	10	20	5	10	20
Variance with village as the unit	157.1	77.7	38.0	151.6	75.1	36.9	160.3	84.5	41.5
Variance with circle as the unit	124.8	60.2	27.9	138.5	67.4	31.9	130.0	63.1	30.0
% gain	25.9	29.0	36.2	9.4	11.4	15.7	23.7	33.7	38.5
ρ_1	0.56			0.42			0.39		
ρ_2	0.36			0.27			0.25		

3.74. An alternative approach for studying the relative efficiency of different sizes of sampling units, which in some ways appears to be more instructive, is due to Hansen and Hurwitz (10, 11). It is based on the concept of intra-class correlation between sub-units of a unit of sampling. If ρ_1 denotes the intra-class correlation between sub-units in a village and ρ_2 that between sub-units in a circle, then neglecting terms in 1/M

$$\rho_1=\frac{\frac{N-1}{N}\,\sigma^2_{sv}}{\sigma_1^{\,2}} \qquad (35)$$

where

$$\sigma_1^{\,2}\simeq\sigma^2=\frac{N-1}{N}\,\sigma^2_{sv}+\sigma^2_{vf}$$

and

$$\frac{N'-1}{}\,\sigma_{sc}^{\,2}$$

$$N'\,\rho_2 \qquad (36)$$

where $$\sigma_2^{\,2} \simeq \sigma^2 = \frac{N'-1}{N'}\, \sigma^2_{sc} + \sigma^2_{cf} \}$$

Substituting these in (33) and (34) we have

$$V(\bar{x}_{n}{}'_{m}{}') = \frac{\sigma^2}{n'm'}\left\{1 + \rho_1\left(\frac{N'-n}{N'-1}\cdot m'-1\right)\right\} \tag{37}$$

$$V(\bar{x}_{n}{}'_{m}{}') = \frac{\sigma^2}{n'm'}\left\{1 + \rho_2\left(\frac{N'-n'}{N'-1}\cdot m'-1\right)\right\} \tag{38}$$

The first factor in the above formulae clearly represents the variance of the mean based on *n'm'* sub-units sampled at random directly from the population, while the second factor measures the contribution to the sampling variance of cluster sampling, the relative efficiency of the two units being given by the ratio of the two variances. The values of ρ_1 and ρ_2 for Delhi data are shown in the Table above.

3.75 The size of plot to be adopted in yield surveys has been a subject of extensive investigations by the Indian Council of Agricultural Research. As stated in Section 3.2, the plot size adopted in the earlier attempts to introduce random sampling in India was small, being of the order of 1/2000th of an acre. The plot size used in similar investigations in U.S.A. and U.K. was even smaller. As against this practice the plot size adopted by the Council was usually the official one in vogue in the provinces, ranging from 1/160th of an acre on paddy in Orissa to 1/20th of an acre on wheat in the Punjab. This was in keeping with the policy of effecting only the minimum essential changes in the official procedure. In view of the wide divergence in usage, however, opportunity was taken in the course of the crop surveys to carry out detailed investigations on the point. The results of these investigations are too well known to need any repetition (22, 23, 24 25). They have shown that small size plots, whose chief merit is that they can be marked by a portable frame and their produce can be handled by the experimenter himself without the help of hired labour, are liable to give biased yield estimates. The risk is particularly serious where, as in this country, crops are unevenly shown and experiments have to be carried out by the local departmental staff in the course of their normal duties. In contrast, the results have shown that large plots of the order of 1/80th of an acre or more are free from bias.

3.76. These results have led to some controversy in India on the question of small versus large size plots but this need not concern us here. Those interested may refer to the correspondence in Nature (9, 22, 24, 25). I may, however, refer to one explanation of these results by Yates suggesting that the bias reported is not improbably due to inexperience and the very careless work of the experimenters (28). Yates is here principally concerned with the magnitude of this bias but his explanation must be rejected since in point of fact the field work was carried out under the personal supervision of trained statisticians familiar with crop sampling work. I would only add that since the publication of our results extensive evidence has been collected, notably by Panse and Paithankar which conclusively shows that plots of very small size like those used in U..K. and U..S.A. or employed in earlier crop surveys in India lead to significant over-estimation of yield (13, 18). Any discussion of the magnitude of the bias or its possible causes such as border discrepancies or faulty location is, therefore, a matter of secondary interest. The important point to note is that in recommending a method for adoption in practice especially in cases where the employment of a special agency of trained technicians is out of the question and the experiments have to be carried out in the unevenly sown crops by the local departmental staff in the course of their normal duties, care has to be taken to see that the method is not susceptible to obvious sources of bias in the hands of the agency employing it.

4. OTHER USES OF SAMPLING

4.1. *Area Statistics*

4.11. The method of complete enumeration for obtaining crop acreages has been briefly referred to in Section 2. Given adequate and effective supervision, the method is known to work satisfactorily in practice. The relative merits of this method and that of random sampling have been a subject of some discussion in recent years in India. We have examined this question in great detail (17.) with special reference to the sample surveys for acreage conducted by Mahalanobis (6). We have concluded that random sampling method, at least as has been developed so far in India, cannot be expected to furnish area estimates for all crops and for all important administrative units except at disproportionate cost and effort and cannot, therefore, be a substitute for complete enumeration. At the same time we do not minimise the role of sampling in improving area statistics in other ways. In this section we shall examine the possibility of using the principle of random sampling for improving pre-harvest forecasts of crop acreages and for providing a rational method of supervising patwaris' work.

4.12. The importance of reliable pre-harvest forecasts of acreage for taking decisions on food policy cannot be over-estimated. Unfortunately. however, records of field to field inspection by patwaris which form the basis of area enumeration are not available until after the harvest is over. In their absence the earlier forecasts of acreage are compiled from the probable estimates of acreage furnished by Revenue Inspectors and Tehsildars on the basis of their knowledge of the conditions under which sowings are made and information on other factors gained in the course of their tours. A comparison of the earlier forecasts with the final ones based on field to field inspection reveals wide differences indicating that earlier area forecasts are not reliable. One method of improving the position would be to get the patwaris to finish the Girdawaris in time for the first forecast. This, however, is not practicable because a Patwari is in charge of several villages and has also to attend to a number of other duties. The other alternative is to develop a suitable sampling technique using village, instead of patwari circle, as the sampling unit of enumeration and employing the *same* organisation and method of inspection as followed in preparing the final area forecasts.

4.13. The possibility of using the method of sampling can be studied most easily when data are available for the whole of the population. An opportunity was, therefore, taken of studying the Khasra registers for all the villages in two districts with a view to find out whether a reasonably small sample of villages could be expected to furnish reliable estimates of acreages in the province. A promising method appeared to be the stratified method of random sampling, stratifying the villages according to their size as determined by the agricultural area in the village and allocating the sampling among the different strata in proportion to the product of the number of villages in the stratum and the standard deviation per village of its agricultural area. The results of the study on four principal crops in the Meerut district using different numbers of strata are shown in the table below :

Number of Strata	No of villages required			
	Wheat	Gram	Maize	Sugarcane
Nil	223(15)	401(24)	377(23)	394(24)
Two	100(6)	181(11)	200(12)	251(15)
Four	68(4)	139(9)	168(10)	218(14)
Five	58(3.5)	128(8)	161(10)	210(13)
Sampling with proby. proportional to size	30(2)	110(7)	125(8)	257(15)

The table shows the number of villages required for estimating the area of wheat, gram, maize and sugarcane with 5% sampling error. The figures in brackets show the numbers of villages expressed as percentage of the total. It will be seen that with 4 strata, only 4% villages are required for estimating the area under wheat with 5% sampling error. The results show that with a sample of about 10% villages, it should be possible to estimate the district acreage under principal crops with sampling errors approaching 5% and the provincial acreages with errors approaching 1%.

4.14. Sampling with probability proportional to the size of a village as measured by its agricultural area is another approach to the problem. The results of the application of this method are shown in the last row of the above table. It will be seen that only 2% villages will be required for estimating the acreage under wheat with 5% error The conclusions in respect of other crops remain more or less unaltered.

4.15. There will of course be some difficulty in applying the results in actual practice for the purpose of improving the accuracy of earlier area forecasts. For, complete enumeration of a village soon after the sowings especially in the rainy season, is always a difficult proposition. Two suggestions offer themselves in this connection. The possibility of getting together cultivators and enquiring from them the names of crops grown on the various plots in their Khasras deserves consideration. The presence of neighbours at such a meeting and the help of detailed maps should ensure accuracy of information. Whatever might have been the reasons in the past for not expecting accurate information from patwaris, they would certainly be not true in the same measure under the changed political conditions of today. Moreover, the information sought has little or no bearing on the revenue to be collected and as such there is no reason to suspect the veracity of the information supplied by the cultivators. The other possibility is to reduce the work in the selected villages by the device of sub-sampling. Without going into a detailed consideration of the question for paucity of space, I shall only add that investigations have shown that, by enumerating only a small fraction of the area in the village, without materially increasing the size of the sample, the provincial acreages can be estimated with reasonable precision.

4.16. The above results also suggest a more rational way of organising the supervision of the work of patwaris by their superiors already provided for under the rules in force. The Land Records Rules for U.P. provide, for instance, that the Supervisor Kanungo should test not less than 7% of the Khasra numbers in each season. Similar rules of supervision exist in other provinces. Without, therefore, having to materially increase the amount of supervision, the results indicate the need of revising the plan of supervision to ensure effective check over patwaris' work.

4.17. Another device in sampling which offers possibilities of forming reliable estimates of pre-harvest forecasts is that of 'identical' samples in consecutive years. Results of the study on two consecutive years' area records for Bajra and Jowar for villages in Haveli taluka in the Poona district given below show the possibility of reliably estimating the change in acreage by enumerating a small number of villages and using the ratio method of estimation on previous years' records. The combination of the device of stratification by size of village with that of 'identical' samples in successive years is found to be even more effective in reducing the size of sample but space does not permit further consideration.

NUMBER OF VILLAGES REQUIRED TO BE SAMPLED FOR ESTIMATING THE CROP ACREAGE WITH 5% SAMPLING ERROR

	Bajra	Jowar
Average per village estimate	102	107
Ratio estimate	28	48

4.2. *Livestock Statistics*

4.21. Results of analysis indicate that for several other agricultural items, the use of village as a unit of sampling is not only administratively convenient but also statistically efficient, provided it is combined with suitable systems of stratification and methods of estimation. Results obtained from the analysis of 1946-47 and 1947-48 data from Haveli taluka for samples stratified by size of village in two categories for estimating the numbers of different livestock are given below. The improvement brought about by the use of the 'ratio' method of estimation using previous years' observations is also shown in the table:—

	Bullocks		Buffaloes	
	Unrestricted	Stratified	Unrestricted	Stratified
Average per village estimate	86	62	79	77
Ratio estimate	67	41	45	42

It will be seen that about 40 villages are required for estimating the total numbers of bullocks and buffaloes in the taluka with sampling error of 5%. The results are tentative being based on studies of one taluka only but they serve to give a good idea of the possibility of estimating the total livestock of different descriptions for a district with a reasonably small sample of villages.

4.22. A number of other small-scale investigations using alternative designs of sampling including sub-sampling, directed towards the examination of the scope for using sampling method for estimating principal agricultural items are in progress in the Indian Council of Agricultural Research. We shall refer here to only one more of these examples concerning the estimation of the total quantity of cattle-yard manure used in fields in a given area. The investigation was carried out in Ajmer-Merwara during 1948-49. The results of the analysis will be found in (27). The analysis indicated that by sampling between 60 to 70 villages per district and making use of the high correlation between the quantity of manure used and the livestock population in the village, the total farm-yard manure for the district could be estimated with about 5 percent sampling error. The use of the regression method of estimation led to a gain of over 60 percent in precision.

4.3. *Grow More Food Statistics*

4.31. Any account of sample surveys in agriculture will be incomplete at the present juncture without a reference to GMF statistics. Though of more immediate concern, GMF statistics stand in greater need of improvement than other agricultural statistics. Large sums of money have been spent on the Campaign but there has been nothing like a serious attempt to scientifically assess its results so far. The GMF. effort is broadly in two directions (a) extension of area under food crops and (b) intensification of cultivation by the use of measures like manures, improved seed and new irrigations. The problem of assessing additional production from the former is straight-forward. It is the latter that presents considerable difficulty and calls for the use of sampling methods. The method at present used for estimating additional production from a GMF measure, say, distribution of Ammonium Sulphate is to assume a certain rate of increase in yield per ton of the fertiliser and multiply it by the total quantity of the fertiliser distributed. The method is open to correction on several scores: (1) the quantity distributed may have found its way to channels unintended. Thus seed may be partially eaten up, manure fed to cattle, diverted to cash crops or applied in doses different from those recommended, (2) the rate of response assumed may not be valid under cultivator's conditions and can hardly be invariant with reference to seasons; and (3) the effect of joint application of more than one GMF measure may well be other than additive. Even the rate of response assumed is empirical and not tested by experimentation on land actually receiving GMF aid. The remedy lies in continuous sample surveys specially designed for the purpose.

4.32. To be put wise about the course of the campaign, however, it is not enough merely to assess the results actually obtained. We also need to know (i) the gains anticipated and (ii) the possible scope for further increase in the anticipated gains. Information on additional production that could have been achieved had all the GMF aid been applied to the intended fields at the prescribed rate and the gains actually made, will the scope for improvement in the operations of the Campaign. An the second question would tell us where and how the could best be expended. The fact is perhaps not noticed that experimentation of the kind refered to above is very properly 'Operational' research in the field of Agriculture, since it primarily aims at providing the Administration with a quantitative basis for taking immediate decisions regarding the operations under their control. The contribution of Operational research to the success of a campaign has by now come to be well appreciated, although the place which operational research has eventually attained had to be hard won as the story from Great Britain which I am tempted to cite below will show. There was, it seems, some difference of opinion between the Operational research team of the Coastal Command and the Bomber Command during the war. The former, it is said, advised the use of twentyfive additional aircraft than were available for the patrol force with the Bomber Command, when an argument ensued and a Senior Bomber Command Officer enquired whether the war was to be fought with slide rules or with weapons. Matters came to such a pass that a trial had to be actually ordered by the Prime Minister and the result proved, much to the amazement of the Bomber Command, that the slide rule had won. Whether in India, where the food front is officially recognised as a war front, the indifference to the kind of research I mentioned above has been due to a genuine paucity of funds or a lack of appreciation of the importance of Operational research in the field of Food and Agriculture, is difficult to say. The moral is obvious. Research is a small investment yielding rich dividends and is it not well known that when a penny must be spent to see if a pourd is well invested, we must not fight shy of the expense especially if we must need to know how best to utilise the few pounds left in hand?

REFERENCES

1 Cochran, W. G. (1939). J. Amer. Statist. Ass. *34*, 492-510
2 Hubback, J. A. (1927) Imp. Agric. Res. Inst., Pusa, Bull. 166
3 Mahalanobis, P. C. (1940), Sankhya *4*, 511-530
4 ——— (1942), "Presidential Address, Section of Statistics"—Indian Science Congress Baroda.
5 ——— (1944), Roy Soc. Phil., Tans, B, 231, 329-451
6 ——— (1945), Sankhya, *7*, 29-106
7. ——— (1946), J. R. Statist. Soc., *109*, 325-378.
8. ——— (1946), Sankhya, *7*, 269-280
9. ——— (1947), Nature, *158*, 799
10. M H. Hensen & W. N. Hurwitz, (1942), Amer. Statist. Assoc., *37* 89-94.
11. ——— (1943), Annals of Math. Statist. *14*, 333-362.
12. Panse, V. G., (1946) Report on the Scheme for the Improvement of Agricultural Statistics, Manager of Publications, Government of India.
13. ——— (1946), Current Science, *15*, 218-219.
14. Panse, V. G. and Kalamkar, R. J. (1944), Current Science, *13*, 120-124
15. ——— (1944), Current Science, 13, 223-225.
16. ——— (1945), Current Science, *14*, 287-291.
17. Panse, V. G. and Sukhatme, P. V., (1948), Ind. Soc. Agri. Statist. *1*, 34-58.
18. Paithankar, M. N. (Unpublished). Thesis submitted for M.Sc. (Agriculture), Nagpur University.
19. Sukhatme, P. V. (1935), J. R. Statist. Soc., Suppl. *2*, 253-268
20. ———(1946), Report on Crop Cutting Experimental Survey for Estimating the outturn of wheat, Punjab (1943-44), Government of India Press.
21. ——— (1945), Ind.J. Agric. Sci., *15*, 308-318
22. ——— (1946), Nature, *157*, 630
23. ——— (1947), J. Amer. Statist. Ass. *42*, 297-310.
24. ——— (1947), Nature, *158*, 345
25. ——— (1947), Nature, 160— 542
26. ——— (1949), J. Ind. Soc. Agric. Statist., *2*.
27. ——— (1949), Compost Bulletin, *2*, 20-23
28. Yates, F. (1949), "Sampling Methods for Census and Surveys", London, Griffin.

SECTION OF PHYSICS

President : Dr. R. N. Ghosh, D.Sc., F. Acust. Soc., F.N.I.

Presidential Address.

Room Acoustics and Ultrasonics

I wish to express my grateful thanks to you for selecting me to preside over the Physics Section of the Science Congress. It is an honour to the particular branch of Physics viz. Acoustics on which I am going to speak; this small branch of Physics had no important place in the past. With the development of the new tool—the thermionic—valve Acoustics has made a rapid progress in the domain of practical field in recent years. In fact it has tremendous applications to Industry and War as well as to the service of society.

In this particular branch of Physics India's contribution is of fundamental character ; the work on the theory of bowed strings by Sir C. V. Raman will remain a monument to the science of vibrations. The mechanically played violin still form a fascinating branch of study of a group of American scientists led by F.A. Saunders[1]. The study of the different parts of the violin has revealed their characteristics and very soon one will be able to purchase a 'Stradivartone" from the market—a result of Raman's researches. Raman and Banerji's work on the vibrations of pianoforte strings was followed by a large number of Indian workers among which the name of Late Mr. Das, M. Ghosh and the author may be mentioned who have extended Raman's work for soft and elastic hammers. One of the important contributions to the sound of impact due to spherical balls is due to Dr.S. K. Banerji[2], the present Director General of Meteorology. Coming to investigations of Indian musical instruments, the study of the harmonic character of Tabla as shown by Prof. C. V. Raman[3] still remain problem for the mathematicians to solve.

This in short represents the early history of the contributions of Indian workers to theory of audible vibrations.

In the domain of high frequency sound waves, Raman and Nagendra Nath's[4] contributions have opened a new chapter in the science of ultrasonics. To quote Bergmann "It was a great achievement on the part of Raman and Nagendra Nath when they succeeded in clearing up the greater part of these phenomena" some of which are very complex. The authors assume that the light waves in passing through a medium permeated by ultrasonic waves are not bent or deflected, so that in passing through the compressions and rarefactions of the medium, only the velocity and hence the phase, but not the amplitude of the light waves, is changed. Hence if a plane light wave passes through a plane sound wave at right angles to its direction of propagation, the sound wave acts like a phase grating. Their theory gives the ratio of the intensities of the diffracted light for two orders *m* and *n* by

$$\frac{Jm^2\ (a)}{Jn^2\ (a)}, \qquad \text{where } a = \frac{2\pi\Delta\mu L.}{\lambda}$$

where $\Delta\mu$ is the change in the refractive index, L the width of the cell and λ the wave length of the light used. This is in excellent agreement with Bar's observed values.

Raman and Nagendra Nath's work was followed by Dr. S. Parthasarathy[5]. He observed the dependence of the diffraction phenomena upon the vibration of angle of incidence and also noticed that a quartz plate vibrates simultaneously at 5/2 & 7/2 harmonics. His later work consisted in measuring the absorption coefficient in various liquids by measuring the intensities of diffracted lights by an ingeneous method. If I_0 and I be the incident and diffracted light intensities after traversing a thickness x, then

$$\frac{I_0-1}{1} = 1 - \frac{\Theta_1}{\Theta_2} = K\, J_0\, e^{-2\alpha x}$$

where J_0 represents the intensity of sound waves at $x=0$, and α the absorption coefficient. Taking logarithms we get $\log e^{(1-\Theta_1/\Theta_2)} = \text{const}-2\alpha x$ Dr. Parthasarathy determined α by measuring the ratio of intensities by photographing two orders of spectra, the intensities being computed by photometric estimation of the density of the plate. Another important contribution is due to the Andhra School of Physics led by Dr. S. Bhagvatam an account of which is given in the Presidential address of (1946) Bangalore Session of Science Congress. The Wedge method of continuously varying frequency enabled the workers to determine the elastic constants of crystals. Work in this direction is being carried on by Dr. Bishambhar Dayal of Allahabad University.

MODERN ACOUSTICS

Modern acoustics to-day has drifted more towards applications, and the theoretical work has to be directed towards that end. It has to serve two-fold purpose. It has to satisfy the public and also the industry. We shall discuss how physicists have been able to serve the cause of science and the public both in their own pursuit after truth.

One of the most important application in the practical field is the study of room acoustics and its correction. After the pioneer work of W. C. Sabine (1900) the subject of room acoustics had become a part of room engineering, and Sabine's reverberation formula

$$t = \frac{\cdot 05V}{\Sigma\alpha S}$$

was used indiscriminately for all kinds of acoustic designs and corrections. Experimental evidence accumulated, however, to show that it is very necessary to use Sabine's formula with care and caution so that Sabine's conditions are satisfied.

Sabine's formula was based upon the statistical behaviour of the room. If we assume a sound pulse to originate from the source it will be multiply reflected from the walls, and therefore when the mean free path of travel of different sound pulses is determined by the statistical method, it comes out to be 4V/S, while Sabine's experimentally detrmined mean free path came out to be 3.7V/S. It is evident that the mean free path will depart from this statistical value if the frequency of the source is low, or the room is large, or the room has a very special geometrical shape. For instance in the case of a spherical or cylindrical chamber the mean free path $p=6V/S$ and $(3\sqrt{2}\ V/S)$ respectively. From the nature of the problem it is evident that if the statistical behaviour is realised, then the intensity will practically be constant everywhere in the room and it will be independent of the position of the source. Under these conditions the growth of sound will be given by

$$E = \frac{4P}{\Sigma\alpha S}\left\{1 - e^{\,tCS/4V\,log\,(1-\bar{a})}\right\}$$

$$\bar{a} = \Sigma\,\alpha\,S/\Sigma S$$

where E represents the energy density at any time t at any point of the room and P the power output of the source, $\bar{a}$ the average value of the absorption coefficient. After prolonging the source for a long time the steady value of the energy density E_s comes out to be

$$E_s = 4P\ c\Sigma\alpha S$$

If you compare this result with the reverberation formula we notice that average detensity decreases as the time of reverberation decreases. Consequently the time of reverberations cannot be indefinitely decreased without impairing audibility. When the source is stopped the fall of energy density will occur in jumps at every instant p/c as given by

$$E = \frac{4P}{c\Sigma\alpha S}\, e^{\frac{CSt}{4V}\,\log\,(1-\bar{a})} \qquad ; \quad S = \Sigma s$$

Corresponding to Eyring's[6] formula for decay the time of reverberation is given by $t=.05V/S\ \log\ (1-\bar{a})$. Modifications to Eyring's formula was suggested by Millington and Sette which we shall discuss later on. These formulæ were used in general by the engineers for acoustic correction and determination of absorption coefficients.

According to Sabine's formula the logarithm of energy density should fall uniformly with time and the intensity has the same value everywhere. This is the result of the statistical theory of sound pulses, that is we have in the room an ergodic conditions with regard to the energy density.

The following oscillograms show the decay of sound in rectangular room of $8\frac{1}{4}' \times 8' \times 6\frac{1}{4}'$ for different driving frequencies namely 220, 335 and 345 cycles/sec respectively. The resonance frequencies of a rectangular room with hard walls are given by

$$\nu = \frac{C}{2}\left[\left(\frac{\eta_x}{L_x}\right)^2 + \left(\frac{\eta_y}{L_y}\right)^2 + \left(\frac{\eta_z}{L_z}\right)^2\right]^{\frac{1}{2}}$$

and the table showing some of the resonance frequencies of the above experimental room has been given below.

The first oscillogram at driving frequency 220 cycles per second shows 6 beats per sec. This is what we expect from the resonance frequencies of the room namely 215 and 221 which are excited when the source stops. Other normal frequencies are far removed from the driving frequency, consequently they are very feeble. At the driving frequency 345 cycles per second the normal frequencies 346 and 343 cycles/sec are excited and we have three beats per second. At driving frequency 335 cycles/sec the component having frequency 333 is strongly excited while the other frequencies are far removed and consequently we do not get any beat phenomenon.

TABLE 1

$n_x\ (l)$	$n_y(b)$	$n_z(h)$	ν
3	1	0	215
1	3	0	221
4	3	3	343
3	4	0	346
4	1	2	333

These experiments were repeated after covering a pair of walls by thick and coarse cloth and it is observed that the beat phenomena disappeared entirely, while the rate of decay increased considerably as shown by the fourth oscillogram at the driving frequency of 345 cycles/sec.

The index numbers which gave rise to the normal frequencies 343 and 346 are (4,3,0) and (3, 4, 0). The result of putting the cloth upon the walls was to damp the waves corresponding to the index numbers (3,4) and (4,3) and consequently the beat phenomenon was suppressed; when the cloth was put up on the floor and ceiling corresponding to the index (0), no change was thereby made, and the beat phenomena persisted because the normal frequencies 343, 346 were present with full volume.

It will also be noticed from the decay curves that the solpe is very steep in the beginning, while at the later stages the slope decreases. The reason for this is that waves falling perpendicularly upon the walls are more absorbed than the waves that graze the surface of the walls. At the initial stages the former set of waves are strongly damped, and at the later stages only those waves are present for which the damping is small; consequently the slope at the later stage is smaller than at the begining.

From these discussions it follows therefore that it is not desirable to put all absorbing materials on one wall; best effect will be obtained by distributing the same over all the walls. These are the important results from the discussions of the waves phenomena, and "caution and understanding" both are necessary in order to apply Sabine's formula for acoustics correction.

The following curves show the resonance frequencies of the room with and without cloth. The prominent peaks without cloth absorbent agrees well with the calculated values. It will be noticed that the resonance peaks near 343 are very strong. Quantitative results have been obtained by Prof. N. B. Bhatt[7], and his work represents the starting point in the era of the wave theory, and the author is indebted to him for his valuable suggestions.

The resonance peaks with absorbent cloth are greatly altered both with regard to frequency and magnitude. A complete discussion of which will be presently undertaken with the help of a solution of the differential equation for the velocity potential in the rectangular chamber.

$$\nabla^2\psi - \frac{1}{C^2}\frac{\delta^2\psi}{\delta t^2} = - q\ (x, y, z; t) \tag{1}$$

where ψ is the velocity potential and $q(x,y,z;t)$ the volume of air introduced by an elementary source at any point (x,y,z) at the time per sec.

Let us consider a rectangular chamber with length, breadth and height along x,y and z axes, and assume that the walls perpendicular to x-axis have specific impedances.

$$Z_{x1}/c\rho = \xi_{x1} \quad , \quad Z_{x2}/c\rho = \xi_{x2}$$

Similar boundary conditions hold for other pairs of walls. We assume a steady state solution $\psi = e^{J\omega t}\ \psi_x\psi_y\psi_z$ where $\omega/2\pi$ represents the frequency of the source ψ_x, ψ_y, ψ_z are given by

$$\begin{aligned} \psi_x &= \cos h \left(J\,\frac{\chi_x\pi X}{l_x} - \phi_x \right) \\ \psi_y &= \cos h \left(J\,\frac{\chi_y\pi Y}{l_y} - \phi_y \right) \\ \psi_z &= \cos h \left(J\,\frac{\chi_z\pi Z}{l_z} - \phi_z \right) \end{aligned} \tag{2}$$

and

$$\xi_{x1} = \frac{l_x\omega}{\chi_x\pi c} \cot h \left(- \phi_x \right) \text{ at } x = o$$

$$\xi_{x2} = \frac{l_x\omega}{\chi_x\pi c} \cot h \left(J\chi_x\pi - \phi_x \right) \text{ at } x = l$$

Writing $\eta_x = \frac{\omega l_x}{\pi c} = \frac{2l_x}{\lambda}$ where λ is the wave ie the wave length of sound

and $\beta_{x1} = \frac{1}{\xi_{x1}}$ we get

$$\text{Cot } h^{-1} \frac{\chi_x}{\beta_1\eta_x} + \text{Cot } h^{-1} \frac{\chi_x}{\beta_2\eta_x} + J\pi\chi_x = 0 \tag{3}$$

where β_1 & β_2 are wall constants. Similar equations are obtained for other pairs of walls perpendicular to y and z axes.

The smallest roots[8] of χ_x

$$\chi_0 = \left(\frac{J\eta}{\pi}\right)^{\frac{1}{2}} \left(\beta_1 + \beta_2\right)^{\frac{1}{2}} \left\{ 1 - \frac{J\pi}{6}\,\eta\,\frac{\beta_1^{3} + \beta_2^{3}}{(\beta_1 + \beta_2)^2} + \ldots\ldots \right\}$$

and

$$\chi_n = n + \frac{J\eta}{\pi n}(\beta_1+\beta_2), \quad n>0 \tag{4}$$

Similarly equations for other pairs of walls.

In the case of free vibrations we assume $q=0$ and $\psi=\psi_N e^{J(\omega_N+Jk_N)t}$ where $\psi_N=\psi_x\psi_y\psi_z$

Substituting this value of ψ in (1) we find

$$\nabla^2\psi_N+\frac{(\omega_N+Jk_N)^2}{C^2}\,\psi_N=0$$

i.e.

$$\pi^2 C^2\left\{\left(\frac{\chi_x}{l_x}\right)^2+\left(\frac{\chi_y}{l_y}\right)^2+\left(\frac{\chi_z}{l_z}\right)^2\right\}=(\omega_N+Jk_N)^2$$

Writing $\chi_x=\mu_x+jk_x,\ \chi_y=\mu_y+jk_y,\ \chi_z=\mu_z+jk_z$

We get

$$\omega_N = \pi C\left\{\frac{\mu_x^2-k_x^2}{l_x^2}+\frac{\mu_y^2-k_y}{l_y^2}+\frac{\mu_z^2-k_z^2}{l_z^2}\right\}^{\frac{1}{2}}$$

$$K_N=\frac{C}{4}\left\{\frac{4\pi\mu_x k_x}{\eta_x l_x}+\frac{4\pi\mu_y k_y}{\eta_y l_y}+\frac{4\pi\mu_z k_z}{\eta_z l_z}\right\}$$

where $\omega_N/2\pi$ and k_N denote the characteristic Natural frequency and the wave damping coefficient. Let us interpret these results.

Writing

$$\frac{1}{\xi} = \nu + J\sigma$$

we find

$$\left.\begin{aligned} \mu_x^2 - k_x^2 &= -\left(\frac{\eta_x}{\pi}\right)\left(\sigma_1+\sigma_2\right) \\ &\quad n^2 - \left(\frac{2\eta_x}{\pi}\right)\left(\sigma_1+\sigma_2\right), \ n>0 \\ \frac{4\pi\mu_x k_x}{\eta_1} &= 2\,(\nu_1+\nu_2), \quad n=0 \\ &= 4\,(\nu_1+\nu_2), \quad n>0 \end{aligned}\right\} \tag{5}$$

$$\text{and } K_N = \frac{C}{8V}\left\{8\,(\nu_{x_1}+\nu_{x_2})\,S_x\,\varepsilon_x + 8\,(\nu_{y1}+\nu_{y2})\,S_y\,\varepsilon_y + 8\,(\nu_{z1}+\nu_{z2})\,S_z\,\varepsilon_z\right\}$$

$$\text{where}\quad \left.\begin{aligned} \varepsilon &= 1 & n&>0 \\ \varepsilon &= \tfrac{1}{2} & n&=0 \end{aligned}\right\} \tag{6}$$

S_x, S_y, S_z represent wall areas perpendicular to x, y and z axes respectively.

Let $\alpha_N = 8\,[(\nu_{x1} - \nu_{x2})\,S_x\varepsilon_x + (\nu_{y1} + \nu_{y2})\,S_y\epsilon_y + (\nu_{z1} + \nu_{z2})\,S_z\epsilon_z]$ (7)

then $K_N = C\alpha_N/8V$ (8)

Writing $E_N = E_{ON}\, e^{-2k_N t}$, we find $t_N = {\cdot}049/a_N$ (9)

t_N denotes the reverberation time for the Nth component, and V the volume of the room. These represent the fundamental formulae which are used for room acoustics.

Two facts emerge out of this expression, firstly the time of reverberation i.e. the rate of decay will be different for different modes acording as the values of ε_x, ε_y ε_z are unity or half according to n_z, n_y, n_z etc. are all greater than unity or zero. If n_x, n_z and n_z are all greater than unity then a_N will be given by (7) and it will be the same for other components for which this condition is satisfied. If $n_x = 0.\ n_y\ n_z > 1$ the wave system is designated as tangential type, the value of a_N is then accordingly different from (7). Similarly for axial waves $n_y = n_z = 0$, $n_x > 1$ the value of α_N will alter profoundly. In the case one wall soft and the other fairly hard, the absorption of both walls is not additive as indicated by formula (7) a_N gives the normal coefficient of absorption, and it does not represent Sabine coefficient

FORCED VIBRATIONS :—Let us assume that the source function can be expressed

$$q(x, y, z\,;\,t) = \sum \psi_N(\omega) A_n c^{j\omega t}$$

for almost hard walls

$$\psi = -\frac{c^2 Q_0}{V} \sum \frac{1}{\Lambda_N} \frac{\psi_N(x_0, y_0, z_0)\psi_N(x, y, z)e^{j\omega t}}{\{\bar{\omega}^2 - (\omega_N + jk_N)^2\}} \tag{10}$$

where

$$Q_0 = Q\Delta V\ ;\ \Lambda_N = \Lambda_x\Lambda_y\Lambda_z\ ;\ \left.\begin{matrix} \Lambda_x = 1 & n_x = 0 \\ \Lambda = \frac{1}{2} & n > 1 \end{matrix}\right\}$$

Since

$$p = \rho\frac{d\psi}{dt} = \rho j\bar{\omega}\psi$$

We obtain

$$p = \frac{-c^2\rho j Q_0 e^{j\omega t}}{V} G_{NN}(x_0, y_0, z_0\,;\,x, y, z)$$

where 'G' is known as Green's source function. When the source is at one corner $\psi_N(x_0, y_0, z_0) = 1$and then

$$p^2 = \frac{c^4\rho^2 Q_0^2}{2V^2} \sum \frac{1}{\Lambda_N^2} \frac{\omega^2\psi_N^2}{\{(\omega^2 - \omega_N^2 + k_N^2)^2 + 4k_N^2\omega_N^2\}} \tag{1I}$$

If we dealing with an isolated single mode of vibration, then the summation sign may be removed. In that case for a given position of source and observer the maximum value of p^2 is $c^4\rho^2 q^2/8V^2\Lambda_N^2 k_N$ and the ratio of $(p\,\omega^2/p^2_{max})$ is given by

$$\frac{|p\omega|^2}{p^2_{max}} = \frac{4\omega^2 k_N^2}{\{(\omega^2 - \omega_N^2 + k_N^2)^2 + 4\omega_N^2 k_N^2\}} \tag{12}$$

If we have two impressed frequencies ϖ' and ϖ'' above and below the peak frequency such that the above ratio *is half in each case*, then we get

$$\varpi'\omega''=\varpi_N^2+k_N^2$$
$$\varpi''-\varpi'=2k_N \tag{13}$$

subject to the condition that the square of the band width be negligible in comparison to the square of the resonant frequency.

Equation 13 has been used by C. M. Harris[9] to determine the decay constant by shifting the frequency of a Beat Frequency Oscillator from the resonance point to a point where pressure was reduced by a factor $\sqrt{2}$. $\varpi' 4\omega''$ were measured by a specially calibrated incremental pitch condenser reading upto .04 cycles/sec. It is important to have stable oscillator in making these measurements. The measurements were carried for different modes i.e. for different values of n_x, n_y, n_z. A typical pressure curve for an isolated mode is shown in Fig. 2*b* which shows the distribution of pressure along x axis for a mode $(n_x,n_y,n_z)=(0.0.1)$, $l_x=7.84'$, $\frac{\varpi}{2\pi}\sim 122$; $x=0$ wall is bare and hard $\phi_x=0$. The other wall is covered with celotex $\nu+j\sigma=.02+j\times.06$.

$$\pi\mu_x \approxeq \cdot 05$$
$$\pi k_x \approxeq \cdot 162$$

It will be noticed that the pressure at the other wall is greater than that at the reflecting hard wall. This is due to the negative reactance of the material used.

When we take the space average we find

$$p^2_{av}=\frac{c^4\rho^2Q_0^2}{2V^2}\sum\frac{\omega^2}{\Lambda_N^2}\frac{1}{\{(\omega^2-\omega_N^2+k_N^2)^2+4\omega_N^2k_N^2\}}$$

If we assume that $n_x, n_y, n_z>1$ i.e. there are oblique waves, the number of components having frequencies between ϖ_N and $\varpi_N+d\varpi_N$ is

$$\frac{V}{2\pi^2c^3}\varpi_N^2d\varpi_N$$

We multiply the above expression by this quantity and integrate between $-\infty$ to $+\infty$, the result is

$$p^2_{av}=\frac{c\rho^2Q^2\varpi^2}{16\pi V}\frac{1}{\Lambda_N}\frac{1}{k_N}, \quad \text{since} \quad \frac{1}{\Lambda_N}=8$$

$$\text{or} \quad p^2_{av}=\frac{4\rho^2Q_0^2\varpi^2}{\pi a_N}$$

where k_N is given by(8)

This is to be compared with Sabine's statistical result

$$p^2_{r\cdot m\cdot s\cdot}=\frac{4\rho^2\varpi^2Q_0^2}{\pi a_s},\ a_s=\sum\alpha_s S$$

Measured by the band width method

The difference lies in the coefficients α_N and a_s ; in the former case α_N represents the absorption coefficient, while α_s is the statistical value of the same for diffused sound.

EFFECT OF NON UNIFOEM DISTRIBUTION OF ABSORBING MATERIAL:—

It has been generally recognised that better room acoustics can be obtained by distributing absorbing material in patches over walls of a room than by uniformly covering the walls. Also measurements show that the decay curve and pressure distribution due to a sound source are dependent *not only on the quantity and admittance of the absorbing material, but on its position and distribution.* The theory of acoustics of rooms with walls non-uniformly covered by absorbing material can be worked 1) by the method of successive approximations, 2) by Fourier expansions and 3) by the application of Dirac's δ function.

Let us consider the case of a rectangular room where the walls are non-uniformly covered by absorbing material. We assume ψ_N the normal potential functions for hard walls, so that $\nabla\psi_N + \frac{k_N^2}{C^2}\psi_N = 0$ when the admittance of the wall is zero. In the case when the walls are non-uniformly covered by patches we asume ψ' which satisfies

$$\Delta^2\psi' + \frac{k'^2_N}{c^2}\psi' = 0$$

where k'_N is complex. Let $k'^2_N = k^2_N + \varepsilon$, so that

$$k'_N = k_N + \epsilon/2k_N$$

Now $$\psi_N\nabla^2\psi_N' - \psi_N'\nabla^2\psi_N + \frac{\epsilon}{c^2}\psi_N\psi'_N = 0$$

or by Green's theorem

$$\int\int \psi_N\psi'_N\left(\frac{1}{\psi_N}\frac{d\psi'_N}{dN} - \frac{1}{\psi_N}\frac{d\psi_N}{dN}\right)ds + \frac{\epsilon}{c^2}\int\int \psi_N\psi'_N dv = 0$$

At $$\beta = 0,\ u/p = \beta k'_N/c\ ;\ \beta = j\sigma + v$$

If $$\psi_N \sim \psi_N',\ \text{then}\ \epsilon = -ck_N'\frac{\int\int\beta\psi_N^2 ds}{\int\int\int\psi_N^2 dv}$$

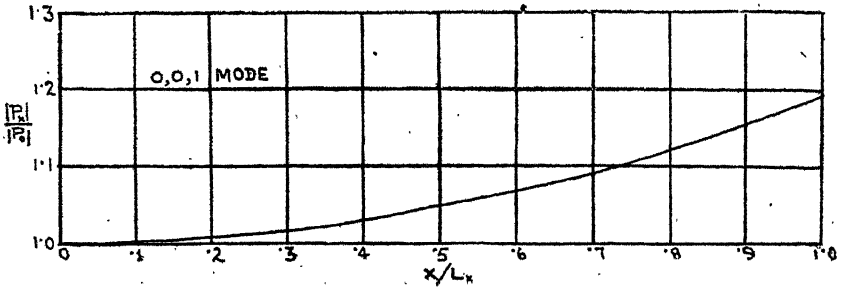
$$\omega_N' = \left\{\omega_N - \frac{c}{2}\frac{1}{V\epsilon_N}\int\int\sigma\psi_N^2 ds\right\}$$

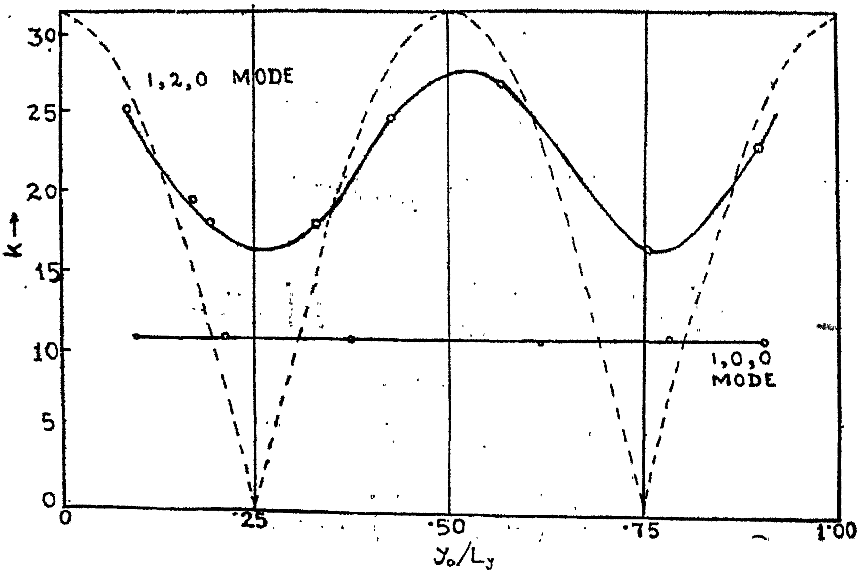
$$k_N\ \text{(damping)} = \frac{C}{2V_0\epsilon_N}\int\int v\psi_N^2\, dS \qquad (10)$$

where E_N represent the mean square value of ψ_N over the entire room. The mean squares ψ_Ns will therefore have a decay factor Exp $\left[-\frac{C\alpha_n t}{4V}\right]$

where $$\frac{\alpha_N}{S} = \frac{8}{2S\epsilon_N}\int\int v\psi_N^2\, dS$$

where S represents the total area of the walls. Several interesting conclusions can be drawn from this first order result. It will be noticed that a piece of absorbing material produces most effective absorption where most of the wave functions have their maxima. In a rectangular chamber, the corners therefore are the best portions for placing absorbing materials. Next best portions are the edges of the walls. In the second place we observe that if the material is to be spread over a number of walls, it is better to place patches of the material in a rather irregular fashion over the walls rather than spreading them uniformly over a wall, since a regular pattern is sure to fall on the minima of some wave functions.





With a single isolated mode of vibration in a small experimental chamber lx, ly, lz, 10″, 8″, 9″ with 5/8″ thick walls, Harris 11) of M.I.T. investigated the absorption due to a patch of material by varying its position on the floor at a fixed distance 'Z' and progressively increasing its distance along Y axis (X-axis being vertical). *Fig.* 2 shows the relative absorption *Fig* 2a for a mode $(n_x, n_y, n_z) = (1, 2, 0)$ frequency 1820. The dotted curve shows the pressure variation in the absence of the patch. It shows two pressure modes as it should be. It will be observed that the absorption is maximum at the pressure maximum. The other curve shows the same for a mode (1,0,0) *Fig* 2b frequency 675; no pressure variation along Y-axis and no change in the relative absorption.

If the absorbing material on a wall is uniformly spread over regions large compared to the wave length, then $\int\int \gamma \psi_N^2 ds \equiv S$ times the constant value of β multiplied by the mean square value of ψ_N on the wall in question,

Hence $\alpha_N = 8(\nu) e_N$

$$e_N = \frac{1}{2} \frac{\text{average value of } \psi_N^2 \text{ over the surface}}{\text{average value of } \psi_N^2 \text{ over the entire volume}}$$

Coming back to the case of uniformly covered walls equation gives at once

$$K_N = \frac{e}{8V} [8 (\nu_{x1} + \nu_{x2}) \epsilon_x S_x + 8 (\nu_{y1} + \nu_{y2}) S_y \varepsilon_y + 8 (\nu_{z1} + \nu_{z2}) \epsilon_z S_z]$$

Let us consider a specific case of a room where all the walls are hard except the walls $x = 0 \quad x = l$, which are uniformly covered by patches. In this case we express

$$\beta_{x1} = \sum \beta\mu\nu \cos \frac{\mu\pi g}{l_y} \cos \frac{\nu\pi z}{l_z}$$

where

$$\beta_{\mu\nu} = \frac{4}{l_y l_z} \int\int \beta_{x1}(yz) \cos \frac{\mu\pi y}{l_y} \cos \frac{\nu\pi z}{l_z} dydz$$

the factor 4 being replaced by 2 or 1 when one or both μ & ν are zero. With the help of equation (10) we get

$$K_N = \frac{C}{2} \left[e_{nx} \frac{(\beta_{x1} + \beta_{x2})}{l_x} \right], \quad \beta_{x1} = \frac{4}{l_y l_z} \int\int {}_N\psi^2 \beta_{x1} d_y d_z$$

or $\quad \beta_{x1} = \beta_x ; O, O + \frac{1}{2} \{\beta_x ; 2\eta_y, O + \beta_x ; O, 2\eta_z\} + \frac{1}{4} \beta_{x1} ; 2\eta_y, 2\eta_z$

and similarly for β_{x2}. These results can be extended to other non-homogeneously covered walls in the same manner.

These methods have however been replaced by more powerful and elegant ones due to the application of δ function. We shall quote some important results.

ERGODIC WAVE MOTION AND INDEX OF RANDOMNESS:—

From these investigations Morse and Bolt have deduced that the wave motion becomes ergodic when patches of material are irregularly distributed over the walls, or the room is irregularly shaped. In the former case the criterion is given by "The index of Randomness" I.R. $_{12}$) for a rectangular chamber

$$I.R = \frac{\frac{1}{2} |\beta| S_\alpha}{\lambda^2 + (4S_\alpha / m)}$$

where $S_\alpha = m\,(ab)$, ab area of the patch of material and $\beta = c\,\rho/z$, λ the wave-length of the sound from the source; m number of patches. When I.R. is smaller than unity, the wave motion is not ergodic (an ergodic wave motion is completely diffuse) in which all the statistical formulas apply—the normal modes having wave-lengths of the order of λ, do not decay at the same rate and the decay curve is not a straight line. When I.R. is considerably larger than unity, the wave motion becomes ergodic—diffuse, the decay rates of the contiguous mode approach an average value; the formulas of geometrical acoustic are then valid. It will be noticed that I.R. will be considerably smaller than unity for very low frequencies. The effect of perturbation of the shape of the wall by bumps or bulges was also considered by Morse & Bolt. We hope to listen to Dr. Auluck's lecture on this subject.

ABSORPTION COEFFICIENT AND ACOUSTIC IMPEDANCE

The discussion on wave acoustics of rooms has led to believe that the room method of determining absorption coefficient will not give correct or consistent results unless I.R. >1* and this involves previous knowledge of the acoustic properties of the room. Repeatable results for the absorption coefficient at normal incidence are obtained by the standing wave method. One of the earliest methods depending upon this principle is due to Paris who used hot wire microphone as detector. A set of clay pipes, diameter about 1′, was jointed together at one end of which a loud-speaker represented the source of sound to produce standing waves, and at the other end in the groove of the pipe a perfect reflector consisting of a thick (1/4″) brass plate was fitted, this could be used as a backing plate to any material cut to the shape of the groove. A sliding wire carrying the microphone at one end detects the sound intensity at different places. The space between the backing plate and the groove has to be made air tight or sound tight so that no sound can leak through it.[13]

The detecting instrument consisted of a cylindrical resonator which could be adjusted to the frequency of the sound, and a hot wire grid—fine platinum wire, diameter .004 mm., carrying 26 milli-amperes, resistance 340 ohms. At the maxima of *particle velocity* the resistance fell by 28 ohms depending upon the heating current and sound intensity. The change of resistance is measured by a battery bridge. Stability of the balance is obtained by inserting a dummy hot wire resonator in the side branch.

It is needless to mention that great caution is required in using the hot wire instrument with a battery bridge which can burn away the fine wire at any slight excess of current.

This method is selective and is very sensitive. The absorption coefficient α is given by

$$\alpha = \frac{4}{(2 + \frac{a}{b} + \frac{b}{a})}$$

where a & b are the amplitude of sound at maxima and minima respectively. The resistance changes are then converted in terms of distances from the minima by replacing the material with the perfect reflector. The ratio $\frac{a}{b} \sim \frac{\sin k_{x1}}{\sin k_{x2}}$, where $k = 2\pi/\lambda$ and $_{x1}$ & $_{x2}$ are distances from the minima when the perfect reflector is introduced.

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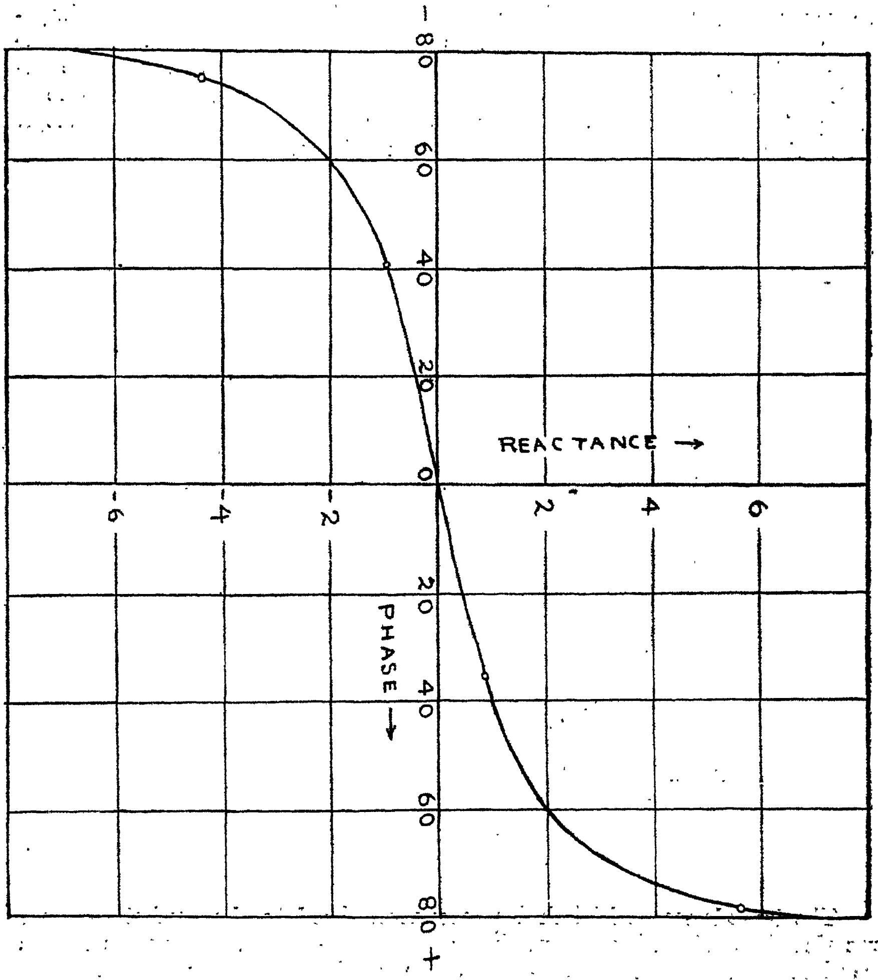
* Sabine noticed variation on the value of the absorption coefficient determined by the room method, for instance the absorption coefficient altered from .43 to 1.26 at 1024 when the sample was shifted from one position to another.

A large pipe of the diamensions used in the experiments is liable to produce radial vibrations which would impair the results.

It will be observed that this method could be used in a more simplified form by replacing the hot wire microphone by a telephone receiver and amplifying the input sound and using a copper oxide rectifier and a galvanometer in the output of the amplifier; the 'noise' from the amplifier is most troublesome in this case. With some caution this simple method gives quick results sufficiently accurate for industrial purposes.

IMPEDANCE CIRCLE METHOD

Dr. Miss Chandra Kanta[14] developed impedance circle method to sufficient accuracy so that load impedance due to acoustical systems could be measured. The method consists in coupling a moving coil speaker of low impedance to an air column in a pipe and determining the impedance of the speaker with and without the air column of various lengths. The resistance and the reactance components are separately determined by means of Campbell's inductometer.



$$Z_{ET} - Z_{EW} = \frac{k^2}{R_p + j(X_p - aZ_o \cot kl)} = R_E + X_E j$$

$ja\ Z_o$ Cot kl represent the load impedance to the speaker

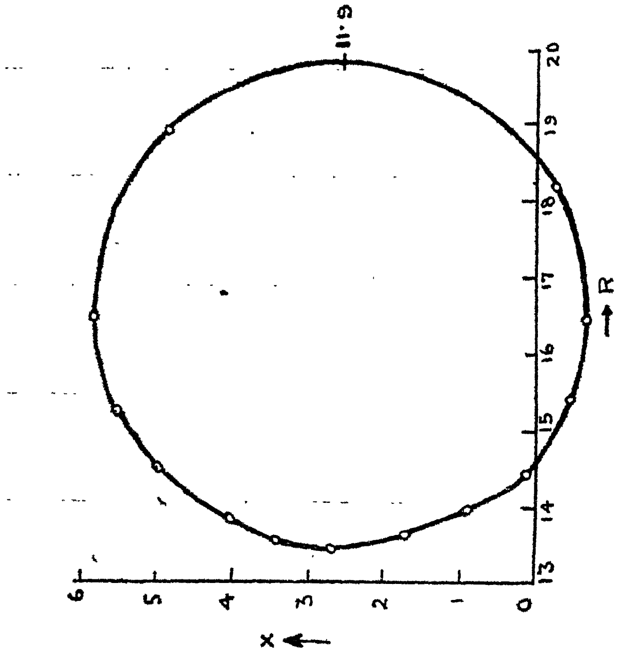
We write this in the form

$$R_E + jX_E = \frac{k^2}{R_p + jX'_p}$$

the quantity—J cotkl represents the air column impedance with a perfect reflector at the end which is added to the mechanical impedance of the system. We find

$$\left(R_E - \frac{k^2}{2R_p}\right)^2 + X_E^2 = \left(\frac{k^2}{2R_p}\right)^2$$

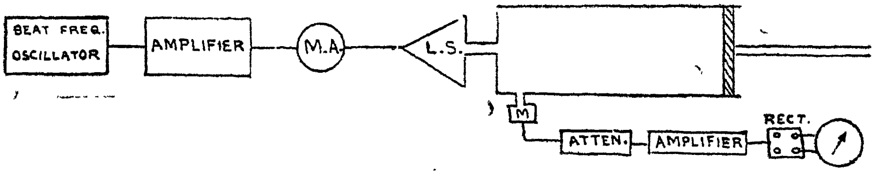
Hence when R_E and X_E are plotted on real and imaginary axes we get impedance circle as shown in Fig. Dr. Miss chandra Kanta used the impedance circle to determine the load impedance and thence the impedance of the imperfect reflector— viz. felt, celotex etc. Dr Chandra Kanta used a pipe of aboug 4″ diameter, a pipe of larger diameter will certainly yield results of sufficient accuracy comparable with other methods.



The impedance of Helmholtz resonators fixed to the perfect reflector was also determined by this method; the phase angles for five resonators are plotted and shown in Fig. 4 These are well known curves. At resonance the phase angle is zero; while on both sides of resonance the phase angle does not extend beyond 90°. These curves lend support to the accuracy of the experimental method.

Half Peak Width Method of Determining Absorption Coefficient :—

This method[15] is now universally used for accurate determination of acoustical impedances of materials. We have adopted this method for determinations as primary standards.



The arrangement is shown above in the block diagram. Fig. 5. The Ls feeds the sound chamber thorugh a high impedance channel, so the reaction on the source is negligible. The piston is adjusted for resonance and the attenuator is set to a high value, and the deflection of the galvanometer is noted. Then the attenuator reading is decreased in steps of a *db* and the pistons moved once outside and then inside the resonance lengths so that the same deflection is again obtained. In this manner readings are taken for several steps of 1 *db*. It is very necessary that the frequency should remain constant when these readings are taken. For this purpose tested tuning forks of high frequency magnetostriction oscillators are used to test the frequency. Similarly the temperature inside the sound chamber must be noted and necessary corrections made. Assuming that radial vibrations are not present, the damping coefficient is given by

$$k=\pi f(l''-l')/l(w-1)^{\frac{1}{2}}$$

(where l', l'', l are the lengths of air column, $w = \frac{|p_m{}^2|}{|p'^2|} = \frac{|p_m{}^2|}{|p''^2|}$) where p', p'' represent the pressure for the corresponding lengths l', l'' and f the frequency of the sound waves.

Since the measurements have been taken in dbs, x dbs. change from resonance will correspond to $w = \frac{x}{10}$ $l.'l''$ are read on the scale of piston corresponding to x db change. Thus all the quantities are known. Hence k is determined. If k be the total damping coeffiecient, kna the same when the perfect reflector is used

$$km = k - kna$$

where km represents the same due to absorption of the material set upon the backing plate. The impedance z is calculated from

$$\frac{Z}{\rho c} = \cot l\left[\left(k-kna\right)\frac{l}{c} + \frac{j\omega}{c}\left\{l_0 - \left(1 - \frac{k^2}{2\omega^2}\right)\left(\frac{t_0}{t_x}\right)^{\frac{1}{2}} l\right\}\right]$$

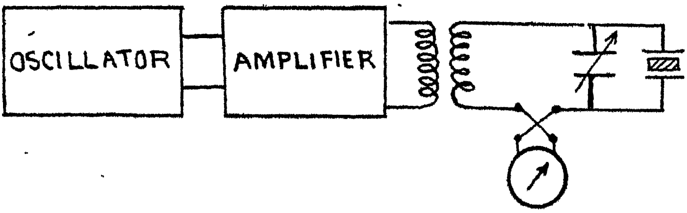
where t_0 and t_x are the absolute temperatures of air inside the tube without and with material backed upon the plate and temperature correction into account. The following curve shows the value of $R/c\rho$ and $X/c\rho$ in the case of three materials viz. celtoex, felt and celotex. Results are within 1% One important result deserves mention, the materials with negative reactance draw the pressure nodes near them and produce more effective absorpion.

PHYSICAL PROPERTIES OF MATERIALS AND ABSORPTION :-

Attempts have been made in recent years to correlate the absorptive power with the physical properties of materials, viz. porosity, flow resistance etc. It would certainly be of great help in the search and preparation of suitable materials for large scale use in theatres and halls. These experiments predict the behaviour of indegenous material such as bagasse or Indian grass. We may mention here that some samples prepared by the Forest Reaserch Institute, Dehradun have been found to possess high sound absorbing qualities. and suitable for large scale use.

ULTRASONIC ABSORPTION

We have referred to the determination of coefficient of liquids by Dr. Parthasarathy by optical means. The reaction of the standing wave upon the vibrating quartz crystal gives another means[16] by which the absorption coefficient can be determined readily. As the perfect reflector is moved and the resonance lengths are increased the reaction decreases exponentially. The equivalent resistance R and the capacity K of the vibrating crystal change to R+ΔR and K+ΔK, and on account of these changes the current in the resonance circuit changes and measured by the thermocouple milliammeter for various positions of the reflector x. Let $\sigma = i/I$, where I represents the maximum current when the crystal is disconnected, then we reduce the reaction by means of the standing wave and the effective changes ΔR and ΔK



$$\left[\frac{1-\sigma\min}{\sigma\min}\right]\left[\frac{\sigma\max}{1-\sigma\max}-\frac{\sigma\min}{1-\sigma\min}\right]\left(1+x\frac{\alpha}{\beta}\right)=\text{const.}$$

to α/β is determined from a series of i_m and x, α being the absorption coefficient, β=reflection coefficient.

The reaction in the case of gases is small and requires very accurate adjustment. Some measurements have been taken at 1.46 M.C. in CO_2 and air at different humidities. These values agree with the classical value.

In the case of liquids ρv is very large ($\sim 10^5$). Hence the above formula reduces to

$$x\,\alpha=\frac{C}{S}\;\frac{\sigma_{\min}}{1-\sigma_{\min}}+\text{const.}$$

Putting $y_1=\sigma_{\min}/(1-\sigma_{\min})$ and noting the slope from the plot of y_1 against x, α is determined. The following table gives the absorption in various liquids for requencies 1.46 MC and 4 M C S.

TABLE

Liquid	Frequency	Temperature	$\alpha(\text{cm}^{-1})$	$\frac{\alpha}{N^2} \times 10^{17}$ sec² cm⁻	Velocity Metres/Sec.
Benzene	1.46 Mc	23°C	.02	940	1320
Acetic Acid	1.46 Mc	23°C	.16	7619	1253
	4 Mcs	23.2°C	.344	2150	1231
Transformer oil	1.46 Mc	23°C	.002	104	1284
Carbon-tetra-chloride	1.46 Mc	23.6°C	.011	507	930
	4 Mc	24°C	.083	520	928

These results are in agreement with the results obtained by other methods. All these absorption coefficients are much higher than the classical values. Transformer oil belongs to that class of liquids of which the absorption is due to viscosity alone.

The Benzene and Carbon-tetra-chloride class are unassociated liquid. In these cases the absorption is about hundred times the classical value. In the case of Acetic Acid two different frequencies namely 1.46 Mc and 4 Mcs were investigated. The following curve is plotted with α/N as ordinate and Log N as abscissa and shows the results of other workers as well as the values determined in our laboratory, It will be observed that acetic acid has got high dispersion in the region of 2.5 Mcs and the maximum absorption takes palce at 2.5 Mcs., The existence of such a maxima was pointed out by Dr. A. K. Dutta[17] in 1941 and with the help of his formula the dispersion in velocity comes out to be 1.4%. In the case of unassociated liquids it has been pointed by Buaer that the maximum of absorption lies in the neighbourhood of one thousand mega cycles and consequently interferometer can not be used to locate them. We have, however, secured a number of crystals of various frequencies and we wish to try some liquids whose behaviour could be known from viscosity data, which we shall presently discuss in the next section.

THEORETICAL DISCUSSION

It will be known that the absorption in the case of polyatomic gases can be attributed to the excitation of vibrational levels of the molecules by the ultrasonic waves, that the absorption is due to lag between the excited molecules returning to their normal levels and time period of vibration of the ultrasonic waves which is known as relaxation phenomenon. In 1938 Kneser applied the same mechanism to explain the phenomenon of absorption in the case of liquids also, that is, it is assumed that in the case of liquids also the molecular vibrational levels are also excited. Recently Bauer has calculated thermodynamically the velocity in the same manner as by Dr. Dutta and evaluated the maximum absorption coefficient with the help of vibration frequencies. Similarly he has tabulated frequencies of maximum absorption with the help of absorption data and the internal specific heat as calculated from the contributions of vibration frequencies. This mechanism is widely believed to be the only factor that contributes to the absorption of ultrasonics energy in the liquids. Sometime back in 1945 Dr. Auluck and Dr. Kothari drew attention that the hole theory of liquids with their quantised values may contribute to the ultrasonic absorption phenomenon. Frenkel also has mentioned in his book that the quasi-crystalline structure of the liquid must take part in the phenomenon of absorption. The authors believe that the hole theory which postulates a quasi-crystalline structure of the liquid must play an important role in the phenomenon of absorption, and dispersion of ultrasonic waves. The quantised hole theory leads to the difficulty of evaluating the energies due to quasi-crystalline structure of the liquid. But the theory of visciosity of liquids based on same assumption makes it possible to evaluate the energy of the quasi-crystalline state of the liquid. The viscosity η^{18} in the case of liquids is given by

$$\eta = B\frac{T}{T_m}\, e^{A/RT}$$

If η and η' be the viscosities at temperature T and T'

$$\eta = R\,\frac{TT'}{T'-T}\log\frac{\eta T'}{\eta' T}$$ for a gram molecule where

A is work function for gram molecule.

Now the internal specific heat C_i is given by

$$C_i = R\left(\frac{A}{RT}\right)^2 \mathrm{Exp}\,(-A/RT)$$

The maximum absorption per wave length is

$$2\mu_m = \pi\frac{\gamma'}{\gamma}\;\frac{\gamma-1}{C_p}\;.\,C_i$$

where γ' represents the ratio of specific heats when ultrasonic absorption takes place and γ the same without absorption. The dispersion frequency is given by

$$N_m = \left(\frac{2\mu_m}{C}\right)\left[\frac{1}{(\alpha/N^2)}\right]\quad N \leqslant N_m$$

The following table gives the values of α/N^2, μ_m and N_m etc.

The experimentally determined value of maximum dispersion frequency in the case of acetic acid is 2.5 Mcs. while the hole theory gives 4.87 Mcs. If we assume that there are vibrational levels in addition, the requisite value of C_i comes out to be .246 cal. deg.$^{-1}$ mole^{-1} and 'A' is 7211 cals/mole. Subtracting from this the hole energy 3291 cals/mole we get 3290 cals/mole—the additional vibrational energy corresponding to frequency 1381± 5cm^{-1} for monomer Acetic Acid.

TABLE

Substance	$\frac{\alpha}{\bar{N}^2} \times 0^{17}$ Sec^{2}Cm^{-1}	C × 10^5 Cms/Sec	A Cals/ mole	Ci Cal dag^{-1}mole^{-1}	$2\mu_m$	N_m.
Carbon-di-Sulphide	10'800	1.14	1802	.8937	.2789	23
Benzene	830	1.31	3148	.2769	.0979	90
Carbon-tetra-chloride	513	.91	3330	.2297	.0652	140
Chloroform	380	.987	2291	.6446	.1806	480
Chloro-benzene	123	1.302	2771	.4295	.1540	963
Toluene	84	1.31	2207	.9181	.2278	2070
Acetone	60	1.17	2250	.6486	.2301	3278
Ethyl-bromide	56	.932	1812	.864	.2608	5067
Acetic Acid	12,000	1.2	3291	.2423	.0701	4.87

APPLICATION OF ULTRASONICS

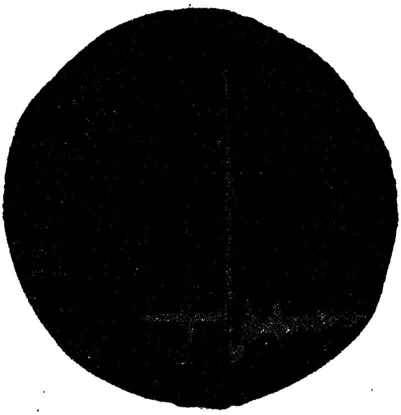
One of the most interesting application of ultrasonics is the determination of elastic constants of solids with the help of the total reflection of the longitudinal and the shear waves when a plate of the solid is rotated in a liquid. The longitudinal wave which is incident upon the surface of the plate is broken up into two waves-longitudinal and shear waves. The critical angle is different for the two waves hence by rotating the solid plate around a vertical axis, first the longitudinal transmitted wave vanishes and then the shear wave.[19]

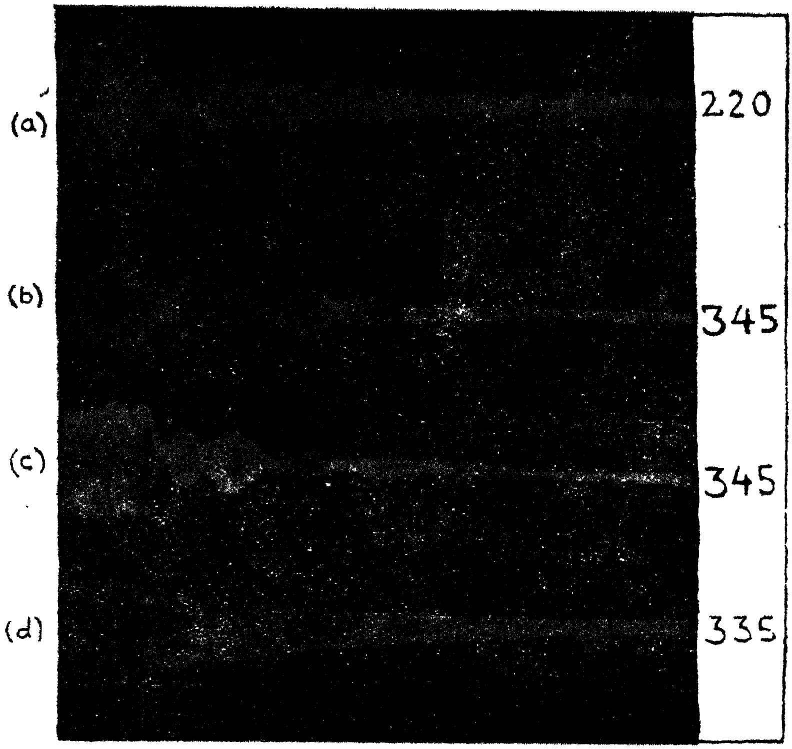
$$V_l = V/\sin \theta_l, \quad V_s = V/\sin \theta_s.$$

The method has been made possible through the pulse technique now available. Pulses short at 2.5 M.C. are generated at regular intervals and sent into the liquid by an x cut quartz crystal, and the transmitted pulses are received by a similar crystal and the incident pulse, the transmitted one are fed into a cathode ray tube. Fig. 7 shows the phenomenon. In addition to the first transmitted pulse, we have other pulses reflected between the solid and the boundary walls of the liquid, and also internally reflected pulses.

A graph of amplitude of the transmitted pulse against the angle of incidence is shown in Fig. 8. The first dip is due to longitudinal wave and the final fall is due to the total reflection of shear wave.

Work on jellies and colloidal solutions are in progress. It will be noted that all these results verify C. G. Knott's theory of regarding the breaking of a wave into longitudinal and shear waves when a wave is incident on the surface of a solid medium.




(a)
220
(b)
345
(c)
345
(d)
335

TABLE

No. Substance	Density	Tank liquid	$V \times 10^{5}$ cm sec	$V_p \times 10^{5}$ cm/sec	$V_s \times 10^{-5}$ cm/sec	$n \times 10^{-11}$ dynes/Cm^2	$E \times 10^{-12}$ dynes/cm^2	μ
1. ALUMINIUM	2.70	WATER	1.5	7.2	2.83	2.16	.609	.406
2. BRASS	8.54	WATER	1.5	4.5	2.33	4.64	1.22	.317
3. IRON	7.86	WATER	1.5	6.1	2.85	6.38	1.78	.361
4. BLACK STONE from MALABAR (South India)	2.99	WATER	1.5	7.23	3.84	4.41	1.15	.303

I have completed adress. I have not been able to do justice to many important contributions of other workers on account of shortness of time. But you will agree with me that the Indians contributed even in this much neglected subject. I feel if some high class young mathematician were drawn into this branch of physics, progress would be much more. There is certainly death of indegenous apparatus. We have been working with crude and improvised apparatus that could be made in India in comparison to the immense facilities in other countries. Much valuable work has been done in this direction by Dr. N. B. Bhatt and Shri D. L. Subrahmaniam; the construction and design of logarithmic amplifier for reverberation measurement and reverberograph sound level meter by these workers represents a land mark, and is hoped that others will take the lead given by them. The time has come that we make our own apparatus not only for our laboratory use but for general public and industrial uses. The talents of the young scientists should now be directed to the perfection of instruments.

In his Electro-acoustic Laboratory at the Indian Institute of Science Bangalore, Dr. Bhatt and his associates have not only constructed equipments like the Sound Level Meter and Reverberation Time Meter but also have designed and developed new equipment.

All these equipments have been constructed from components easily available in any electronic laboratory. The Sound Level Meter conform strictly to the specifications of the American Standards Association. It employs a moving coil microphone instead of a Crystal microphone as is usually done in commerical instruments ; this makes the equipment better suited for tropical countries, where the crystal microphone looses its sensitivity and becomes inactive. A new type of calibrating the Sound Level Meter is also developed. Much work still remains to be done in this direction. Thank you gentlemen.

REFERENCES

1. F. A. Saunders *J. A. S. A.* 9, 82, (1937)
2. S. K. Banerjee. *Phil. Mag.* 32, 96, (1916).
3. C. V. Raman. *Proc. Ind. Acad. Sci.* 4, 179 (1934).
4. Raman and Nagendra Nath. *Proc. Ind. Acad. Sci.* 4, 2, 406 (1935)
5. S. Parthasarathy. *Proc. Ind. Acad. Sci.* 3, 442 (1936)
6. Eyring C.F. *J. A. S. A.* 1, 217 (1930)
7. N. B. Bhatt. *J. A. S. A.* 11, 65 (1939)
8. P. M. Morse, *Rev. Mod. Phys.* 16, 101 (1944)
9. C. M. Harris, *J. A. S. A.* 17, 36 (1945)
10. DAH-YOV-MAA. *J. A. S. A.* 12, 242, (1940)
11. C. M. Harris, *J. A. S. A.* 17, 242 (1946)
12. P. M. Morse *Rev. Mod. Phys.* 16, 134 (1944)
13. Haji Gulam Mohammad. *Proc Nat. Inst. Sci.* (Indian) 4, 316 (1938)
14. Chandrakanta (Miss). *Proc. Nat. Inst. Sci.* (India) 6, 671 (1940)
15. LEO L. Beranek, *J. A S. A.* 12, 3 (1940)
16. J. C. Hubbard *Phys. Rev.* 41 (1932)
17. A. K. Dutta, *Trans. Rose, Res. Inst.*(13) 31 (1937-39)
18. R. Fruth, *Proc. Camb. Phil. Soc.* (1941)
9. C. G. Knott, *Phil. Mag.* (1898).

37th INDIAN SCIENCE CONGRESS, POONA, 1950

SECTION OF CHEMISTRY

President: Dr. J. K. Chowdhury, Ph.D., F.N.I.

Presidential Address

THE UTILIZATION AND DISPOSAL OF INDUSTRIAL WASTES

THE NEED FOR A NATIONAL PROGRAMME

It is a great honour and privilege to be elected President of the Chemistry Section, the largest and perhaps the most important section of this premier scientific organisation, meeting in this historic city of Poona. This honour would have been more enjoyable, had it not carried with it the obligation of delivering a presidential address. The selection of a suitable subject has been a problem to me. It was not easy to choose between a specialised branch of knowledge and one of general interest. After some hesitation, I have decided to speak to-day on the 'utilization and disposal of industrial wastes', partly because of the importance of the subject for public welfare and partly because it does not appear to have received the attention it deserves in this country. With the likelihood of great industrial expansion in the immediate future, this subject also appears to be an opportune one at the present moment.

"Waste" is perhaps not an appropriate word to use. What is waste to-day may be a by-product of considerable value tomorrow. It is well-known that in the case of coal carbonisation, the by-products have become more important than the main product. A typical example of our continued change of the idea of value is furnished by monazite sand which occurs in large amounts in the sea coasts of Travancore and was once considered to be a mineral of no value at all. On account of its high specific gravity, it was used as ships' ballast in their return journey from India. The discovery of Auer von Welschbach first drew the attention of the world to monazite sand as a source of thorium for the manufacture of gas mantles. The use of cerium as an alloying metal further increased its importance. The development of atomic energy has now turned all attention to thorium—an element very similar to uranium in atomic structure and to-day monazite sand is considered as a strategic mineral of national importance.

Utilization of low grade materials for the production of valuable articles is one of the proudest achievements of chemistry. Although conversion of base metals into gold is no longer the aim of the modern chemist, he is still guided by the basic idea of obtaining more costly materials from less costly ones. In this attempt, impurities in the raw material, reinforced by various amounts of chemicals and other materials added during the process of extraction, form large amounts of waste products in solid, liquid or gaseous state. In quantity these waste materials often outweigh the valuable product. Solid wastes are usually dumped in low lands and often become a nuisance to the locality. Gaseous wastes, unless harnessed for use, may cause considerable injury to health and property. In solution or suspension in water, they serve to pollute streams and rivers, and constitute a danger not only to aquatic life but also to the inhabitants of the area.

The impending industrialisation of the country, concentration of industries in certain areas and the increase of urban and industrial population will further aggravate the trouble. It is the responsibility of the industries to deal suitably with the waste problem which is their own creation. It appears that industries in western countries are now quite alive to this responsibility. Superior technical staff, formerly employed on problems of production, is being increasingly diverted to tackle problems of pollution ; adequate financial provisions are made for the construction and working of costly plants with a view to recover marketable products and dispose of the residues in a harmless manner.

The utilization of waste materials depends largely on the cost of the processes involved and on the cost of collection. Where the operation is profitable, by-products are recovered without much difficulty. Sometimes the waste of one industry is used as a raw material in a sister industry. In this way a group of interdependent industries spring up in certain areas. Where the operation may 'break even', without bringing any reasonable gain or may involve a slight loss, private enterprise is naturally reluctant to come in. It should however be remembered that the responsibility of eliminating the waste primarily rests on the industry which generates it. The cost involved in reclamation and disposal processes should form an integral part of the industry as a whole and should be taken into account in fixing the price of different products. In no case should such operation be regarded as an isolated industrial unit. If the cost of equipment and other expenses be too heavy for any particular industry, it would be open for the state to extend a helping hand and offer such financial and technical assistance as will meet the situation.

The value of an undertaking should not be judged from the point of view of profit alone when it happens to play an important role in our national economy or general welfare. Considering the size and population of the country, India is relatively poor in the supply of many important raw materials. Our natural resources for the supply of sulphur, fertilisers, mineral oils and many important metals such as lead, zinc, cadmium, vanadium, molybdemum etc. are far from satisfactory It is therefore imperative that we should try to widen our raw material position. Formerly this was done through wars of conquest or through the exploitation of backward people. Science has opened up new methods more potent than older ones.

RECOVERY OF SULPHUR

A short survey of the methods of recovery of sulphur and a few other important materials will illustrate the point in issue. Sulphur occurs as sulphuretted hydrogen in various fuel gases. In the purification of these gases, sulphuretted hydrogen has to be removed almost completely. Sulphur also occurs as sulphur dioxide generated in the combustion of coal and in the smelting of sulphurous ores. When discharged into the atmosphere, it causes considerable damage to vegetable life, industrial plants and household equipments.

Recovery and utilization of sulphuretted hydrogen.

In the drive for national self-sufficiency, recovery of sulphur as a by-product has been practised on a large scale in Germany. Reclamation measures have succeeded in making the country largely independent of foreign supplies. Coke oven gas, low temperature carbonisation gas, synthesis gas and gases evolved in coal hydrogenation were used for the extraction of sulphur. The following figures of the production of elementary sulphur in Germany are illuminating:

1927	10,000 tons
1937	32,000 tons
1938	50,000 tons
1939	70,000-80,000 tons (estimated)
1941	180,000-190,000 tons („)

The enormous increase in the production of synthetic oils in Germany during the war years was accompanied by corresponding increase in the production of sulphur. In U.S.A. inspite of the occurance of extensive deposits of natural sulphur, recovery of byproduct sulphur has been practised on a large scale. Here natural and refinery gases form the greatest source of sulphuretted hydrogen. It has been estimated that in 1939, U.S.A. produced abcut 50,000 tons byproduct sulphur of which nearly 10,000 tons were in elementary form and the remaining 40,000 tons as sulphuretted hydrogen converted directly into sulphuric acid.(7)

In recovering sulphuretted hydrogen from various gases, two types of processes are generally used—the dry processes and the wet processes. Although numerous processes have been developed, coke oven gases are still refined by the traditional process of passing the gases through hydrated iron oxide. The efficiency of absorption falls considerably when the S-content reaches 40-50%. In Germany this sulphur is extracted with carbon disulphide, though the operation is not economic and the sulphur has to be further purified. In U. S. A., no use is made of this spent oxide, while in England it is used to some extent for the manufacture of sulphuric acid. On the whole it can be said that no economic and satisfactory use has yet been found for the vast mass of spent-oxide used in refining fuel gases.

In Germany synthesis gases are purified also by the use of activated carbon for the catalytic oxidation of sulphuretted hydrogen to sulphur, which is then extracted with suitable solvents. Formation of tarry matter and consequent loss of activity of the active carbon have limited the usefulness of this process. It has been claimed that special types of activated carbon, free from these defects, have been successfully evolved in Germany.

For the recovery of sulphur, wet processes are more suitable than dry processes. The final removal of traces of the sulphur compound by these processes is rather costly and hence these processes are usually followed by iron oxide refining. Recent development of two stage wet processes, however, permits almost complete removal of H_2S without substantial increase in cost. These wet processes may be classified in the following three groups:

(*i*) When ammonia is present in the fuel gases, ammonium sulphate and sulphur are recovered in one operation, involving oxidation of sulphuretted hydrogen to sulphur by air or other oxidising agents.

(*ii*) Oxidation of sulphuretter hydrogen is brought about in solutions by a chemical reagent which is thereby reduced and is regenerated by the blowing of air. Sulphur in finely divided particles, usually in the form of slurry, is obtained by these processes.

(*iii*) Sulphuretted hydrogen is absorbed in suitable solutions at a low temperature and is then expelled in the heat as practically pure H_2S. It is then converted either into sulphuric acid if there is demand for it in the neighbourhood or into elementary sulphur if it is intended to tap a wider market.

The Katasulf and the Kohlentechnik processes (1) both developed in Germany are typical representative of class (*i*) processes. Though special advantages are claimed, actual production of sulphur and ammonium sulphate by these processes does not appear to be great. The Thylox process and the Staatsmijnen—Otto process are typical representatives of class (*ii*). The Thylox process uses a solution of sodium thioarsenate containing 0.7% As_2O_3 and maintained slightly alkaline (pH 7.6-8.0) for the absorption of H_2S. The solution is then pumped to a tall tower where it is regenerated by blowing air and the sulphur is 'floated' to the top and filtered. The sulphur-cake however contains large amount of water. By the use of the two stage Thylox process, almost complete removal of H_2S may be secured without substantial increase in the cost of operation. More than two dozen plants of this type are in operation in U.S.A., Germany and Japan. All kinds of fuel gases are said to be amenable to treatment by this process.

The Staatsmijnen-Otto process (4) uses ferric-ferrocyanide solution for the absorption of H_2S. The ferrous salt formed in the reaction is regenerated to original form by passing air when it becomes suitable for reuse, while the sulphur is carried upwards as a foam or paste. The non-poisonous character of the solution and the higher purity of sulphur make this process attractive. The nickel process (10) also claims high efficiency and purity of sulphur and is successfully used in several plants in U.S.A.

The phenolate process developed by Koppers in U.S.A. and the Alkazid process developed by I.G. in Germany are typical representatives of class (*iii*) processes. A few other processes using aromatic amines, suspension of Magnesium hydroxide in water, solution of sodium or potassium borate and phosphates have also given promising results.

The phenolate process (7), as the name indicates, uses a concentrated solution of sodium phenolate, in which the proportion of sodium and phenolate radicals may vary within wide limits. Sulphuretted hydrogen is absorbed at a low temperature (25°C), when evidently it is the stronger acid than phenol. At the regeneration stage, when this foul solution is heated to boiling temperature, the phenol becomes the stronger acid and therefore drives out H_2S from the solution. This process is operated either in single stage or in two-stage processes. When it is intended to remove, say, 90% of H_2S in a gas, the one-stage process has been found more economic. When complete removal of H_2S is desired, steam consumption (12.0 lbs.), by the single stage process is rather excessive. In such a case, two-stage process has been found economic, as it requires only 3.5 lbs. steam per lb. of H_2S recovered. This process is usually followed in U.S.A. for refinery and natural gases which are normally worked under high pressure. But it may also be adapted for low pressure and low sulphur gases such as the coke oven gas. Two Oil Companies of U.S.A. the Altantic Refining Co. of Philadelphia and the Standard Oil Co. of California, are reported to be treating more than 55 million cu.ft. of such gas per day, recovering more than 26,000 tons of sulphur per annum.

The alkazid process (8) uses water solution of alkali or alkaline earth salts of certain amino acids (e.g. glycocoll or alanine) for the absorption of H_2S which is absorbed in the cold and expelled by heat, thus regenerating the solution for fresh use. This process is extensively used in Germany and is responsible for the production of more than 30,000 tons of sulphur annually (1939).

The Girdler process uses a concentrated solution of mono, di and tri-ethanol amines in water to absorb sulphuretted hydrogen. This process is largely used to recover carbon dioxide from flue gases. Several plants for the manufacture of dry ice are operating this process in U.S.A.

The pure sulphuretted hydrogen gas generated by the above processes is either converted into sulphuric acid by the catalytic process or to elementary sulphur by oxidation in Claus furnace improved by I.G. (8) using bauxite or some other catalysts (5). For the purpose of conversion into sulphuric acid, H_2S, is oxidised to SO_2 and H_2O,freed from water vapour and the dry sulphur dioxide converted to sulphuric acid by the usual contact process. In recent years, Lurgi Chemie has developed the wet catalytic process which eliminates the step of removing water vapour. The wet SO_2 gases are passed directly over the contact mass and the products are cooled by condenser without formation of mist. This process is in operation in several plants in Germany and England.

As numerous new processes for the extraction of sulphur are coming to the fore and as constant improvements are being made in old ones, it is difficult to form a clear idea of the comparative merits of different processes. The following table (1) based evidently on data of the working of 1937 will give some idea of the relative importance of the processes followed in Germany.

	Process	Range of optimum S-content in gas g|m³	Type of gas used	Amount of S recovered (tons)
1.	Dry process using Fe_2O_3	7-12	Coal gas	14,000
2.	-do- active carbon	3-4	Synthesis gas	10,000
3.	Kohlentechnik	8-12	Coke oven gas	
4.	Thylox	7-15	-do-	4,500
5.	Girdler	above 10	-do-	
6.	Phenolate	above 10	-do-	..
7.	Alkazid	above 10	Coke oven and synthesis	17,000*
8.	Katasulf		Coke oven	1,000

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*This figure is reported to have increased to 30,000 tons in 1939.

Utilization of waste sulphur dioxide.

Vast quantities of sulphur is lost as sulphur dioxide generated by the combustion of coal and by the smelting of sulphur-bearing ores. When the concentration of sulphur dioxide is high (7% or more), as is the case with the roasting of pyrites and zinc ore, the utilization does not present any special difficulty. The concentration of the gas generated in several roasting operations, however, falls considerably below this figure and often lies between 0.5 and 2%,—a concentration in which sulphur was not thought to be recoverable. The concentration of sulphur dioxide in industrial flue gases is even lower and varies considerably with the sulphur content of coal. The sulphur dioxide evolved in these operations has injurious effects on animal and vegetable life and is responsible for considerable economic loss caused by the corrosion of metallic parts of industrial and household equipments.

During the last decade, substantial progress has been made in the recovery and utilization of sulphur dioxide and a large number of processes claims success in this field. The essential principle in all these processes is, first, to strip sulphur dioxide from dilute gases by means of absorbents and then to release the gas in concentrated form usually by the action of heat. The concentrated sulphur dioxide is then used for the manufacture of sulphuric acid, paper pulp and other industrial purposes. It is also reduced to elementary sulphur, in which form it serves a much wider market and can be easily transported.

Although a large number of processes have been developed in recent years, only a few of the more important ones are mentioned here:

(*i*) At Trail, Canada, the Consolidated Mining and Smelting Co. uses ammonia as the primary absorbent. In this process sulphur dioxide is absorbed in scrubbing towers until a strong solution of ammonium bisulphite with some normal sulphite is obtained. It is then treated with sulphuric acid, forming ammonium sulphate and releasing sulphur dioxide in concentrated form. This sulphur dioxide may either be used for sulphuric acid and other industrial operations or may be reduced to elementary sulphur according to market demand. Nearly 200 tons of sulphur is produced in this plant per day. In Germany, the Metalgesellschaft A.G. (8) has been successful in preparing ammonium sulphate by reacting a mixture of these dilute gases and air with finely dispersed ammonia, thus avoiding the consumption of sulphuric acid.

(*ii*) An excellent process, known as the sulfidine process, has been developed by Lurgi Chemie in Germany (11). A water suspension of some aromatic amines is used as absorbent. As sulphur dioxide is absorbed, the sulphite goes into solution. When heated to 80-100° C, pure sulphur dioxide is given off and the absorbent separates again to form an insoluble layer and is reused. This process has high efficiency and is in successful operation in Germany. Sulfidine solutions are selective in their absorption capacity, sulphur dioxide being preferably absorbed from a mixture of the gas with carbon dioxide (*iii*) The Imperial Chemical Industry's process (Billingham, U.K.) uses basic aluminium sulphate as absorbent and almost pure sulphur dioxide is expelled by heat.

The reduction of sulphur dioxide into sulphur is usually carried out either by (a) the Bolidens process (7) of catalytic reduction with gases from coke fired furnaces or by (b) the two stage reduction process of I.G. (11) in which sulphur dioxide is reduced first at 900°–1200° C with coke and the gaseous products are again heated with sulphur dioxide at 500°-700° C when they are freed from COS and CS_2, yielding elementary sulphur and carbon dioxide.

India's present requirement of sulphur is about 45000-50000 tons per annum and is met wholly by import. Next to soda ash and caustic soda, it stands highest in import value. Foreign currency worth more than rupees 50 lakhs would be saved if the country's requirements could be met internally. There are vast deposits of sulphur-containing coals in Assam, in which sulphur content is nearly 4% on an average. It is generally consumed in furnaces with large excess of air. As a result, the concentration of SO_2 in flue gases is rather low and lies between 0.2 and 0.5% by volume. In improved furnaces using less excess of air for combustion, the concentration is considerably higher. Low as this concentration is, it is still recoverable with the help of modern methods. If this coal were subjected to low temperature carbonisation or to hydrogenation processes, either directly or by the Fischer-Tropsch process, the concentration of sulphuretted hydrogen would be very high and economic recovery of sulphur would be practicable. It is interesting to note that British Power Plants have been treating concentrations of .05-.2% sulphur dioxide with 99.7% efficiency (18).

It has been stated that about 20 tons of sulphur is lost every day as sulphur dioxide, produced in the smelting of chalcopyrites in Singhbhum district. It is worth while to explore the possibility of its utilization. The synthetic ammonia plant at Sindri, situated not very far from Singhbhum, has opened up new possibility of its utilization by the Canadian or German processes. It should not be too costly to transport ammonia from Sindri to Ghatsila (Singhbhum). If the sulfidine process or I.C.I. process is found to be more suitable, sulphur dioxide recovered at Ghatsila, could be transported without much difficulty in the reverse direction for conversion into ammonium sulphate at Sindri by the Maschinengesellschaft or other processes. At present, the production of ammonium sulphate in the Sindri plant is dependent on distant sources of gypsum. The development of an alternative process would impart greater flexibility to the Sindri plant which could switch over to either of the processes according to circumstances.

RECOVERY OF PHENOL FROM WASTE WATER

At present India imports about Rs. 28,000 worth of phenol but this low consumption does not fully reveal the commercial importance of this product. The expansion of the chemical, pharmaceutical and munition industries in this country, the manufacture of plastics and herbicides of the plant hormone type will create considerably greater demand. The waste water of coal carbonisation and tar distillation industries carry considerable amounts of phenol into the river system. Even a very small concentration imparts repugnant taste and odour to water. When drinking water is chlorinated, it results in the formation of p-chlorophenol which, even in great dilution (.02 p. p. m.), imparts a characteristic medicinal taste, so familiar to many of us. While phenol is slowly destroyed by the natural process of oxidation, the p-chloro compound is resistant to such oxidation and this explains the persistence of the taste in chlorinated drinking water. When concentration of phenol in waste water is low (1-30 p.p.m.), it is easily destroyed by biological processes of oxidation. Such waste water is usually led into the sewers and no attempt is made to recover phenol. The concentration may however rise to a considerable extent. Ammonia still wastes, for example, have been found to contain 1000-2500 p.p.m. of phenol. Phenol may be removed from such water by extraction with benzene and other solvents from which it is recovered by treatment with alkali and the solvent reintroduced into the process. The absorption capacity of tricresyl phosphate for cresols and phenol has been found to be much greater than that of benzene. The recovered phenol is however impure, contains high boiling fractions and has to be refined before use. In 1937 the German plastic industry used 30,000 tons of phenol of which 5000 tons were reclaimed material.

A process by which phenol is recovered in a purer state has been developed in U.S.A. (3). In this process ammonia liquor is first freed from CO_2 and H_2S in the upper section of the conventional ammonia still and is then passed into a dephenoliser,—a packed tower where it comes into contact with steam. The steam carrying the phenol passes into a second tower where it is scrubbed with caustic soda solution maintained at suitable temperature to prevent dilution. The liquor from the first tower goes to ammonia recovery plant, while the alkaline extract from the 2nd tower is treated for phenol recovery. The quality of this phenol is said to be exceptionally good.

EXPLOITATION OF MUNICIPAL WASTES

Municipal wastes primarily consist of (*a*) street and domestic refuse and (*b*) sewage. The rapid growth of urban population has led to enormous increase in both these wastes and their satisfactory disposal has become a problem. In recent years, considerable progress has been made in the rational utilization of these wastes. For this purpose, the refuse matter and sewage are generally treated separately, although in a few instances, mixtures of organic refuse and sewage have been used.

Municipal Refuse

The primitive method of using refuse matter to fill up low lands and ditches is still followed in several towns. But the obnoxious odours and hygienic considerations have rightly brought such use into disfavour. Incineration has been practised in several towns and later attempts were made to utilize the calorific value for raising steam and generating electricity. The low calorific value of these waste materials is further lowered by the presence of moisture and inorganic matter such as ash, concrete etc. and hence their utilization as fuel is not a simple matter. The residual ash from these fuels has been used as an excellent road building material. Mixed with cement, this ash has given artificial stones used for pavements and buildings.

Attempts were made to gasify refuse matter in producer gas generators and to subject it to low temperature carbonisation. Several other uses have been tried *e.g.*, manufacture of fuel briquettes and preparation of light building materials by pressure. None of these processes seems to have found favour in large scale practice.

Rational utilization of refuse matter must be based on its composition which varies within wide limits. The inorganic matter consists of useful materials such as tins, metal scrap, glass etc. and less useful materials such as stone and brick chips, kitchen ash and the like. The organic matter consists of rags, paper, bones, rubber, cooked food and sweepings of houses and streets.

Sorting is the basis of modern utilization processes. Female labour is usually employed for picking up more useful materials such as tin vessels, scrap iron, non-ferrous metals, paper, rags, glass, rubber and similar articles. These materials are then despatched to appropriate industries which use them as raw materials. In 1936, the city of Berlin collected 10,000 tons of these useful materials from street refuse, valued at R.M. 270,000. In 1937, sorting of refuse was enforced in all German towns with a population of 35,000 or more and huge quantities of useful materials were reclaimed. To mention only one item, about 280,000 tons of rags were collected in that year (2).

The residual organic matter, left after sorting contains nitrogen, phosphorus, potassium and calcium. When added to the soil, it not only supplies these plant nutrients but also the organic matter which decomposes into humus, retains moisture in the dry season and improves soil texture. Formerly, the usual method was to spread it on the soil and plough it in. Later this practice was improved, *e.g.* in Barren islands U. S. A. where the refuse was steamed for several hours in closed vessels, fat and water removed and the residual solid matter dried, crushed and sold as artificial manure. It was found that fresh refuse led to heavy incidence of disease and crops susceptible to salts suffered most. With time, however, the organic matter weathered and improved the ability of soil to hold water. The time required for this ageing process was too long and various artificial processes of ageing or 'composting' were developed to accelerate the process. The Beccari process was carried out in closed chambers, accompanied by a rise of temperature and required about 38 days. At the Hague, where the refuse was stacked in heaps, it required 2-3 months. At Salzburg, the refuse was mixed with sewage and ripened in beds under anaerobic conditions. A similar process developed by C. N. Acharya is followed by several municipalities in India and yields a product of high fertilising value. The process followed by the Royal Borough of Kensington is a typical example of these biological processes and may be briefly described here (15).

The refuse is dumped into large pits screened to prevent egress of dust. It is then conveyed mechanically to the top of a few towers whence it passes to belt conveyors. Here articles such as metals, papers, rags, glass etc, are picked out by hand. It then goes to rotating cylindrical crushers, screened, sprayed with bacterial cultures and conveyed to closed chambers, where it undergoes fermentation—anaerobic and aerobic—for a period of about sixteen days. The temperature rises to 170—175° F, gases are removed through flues and may be utilized as fuel. The nitrogen content of the residue varies from 0.97—1.42 per cent (average 1.16%) and its moisture content is only 30%. At Rothamsted, this manure has been tried for several crops under various conditions of soil and it has been found superior to cowdung for the same nitrogen content.

Sewage

In the larger towns provided with sewage system, huge quantities of this 'nuisance' have to be disposed of in a hygienic manner. This task imposes a heavy financial burden on the municipal authorities. A close examination of the nature and composition of sewage revealed that it had economic possibilities and the idea of combining disposal of sewage with its economic exploitation gained strength.

Sewage consists of a mixture of human excreta, city's drainage and industrial effluents. Human excreta consists of a large quantity of organic matter in addition to plant nutrients like nitrogen, phosphorus and potassium. As sewage contains other materials besides human excreta, its analysis differs considerably. In addition, it contains numerous bacteria, fungi and other micro-organisms. A good method of utilization should take this fact into account and should make proper use of these micro-organisms.

Originally sewage was discharged into rivers and streams without any previous treament. Here they underwent a process of self-purifiction—a part of the material dissolved in water and was oxidised by air, a part was acted on by bacteria forming gases, sediments and soluble substances and a part formed insoluble sludge. The capacity of rivers for this self-purification process is limited and depends on the volume and flow of water, which vary greatly according to season. In many instances, the water becomes seriously polluted. Later some improvement followed when the solid sludge was separated by sedimentation before leading the overflow effluents into the rivers. Fermentation of the sludge in tanks, and the soluble organic matter and micro-organisms discharged into the rivers, however, created a situation difficult to deal with.

Then followed attempts to combine disposal of sewage with its utilization for agriculture. The raw sewage was carried to distant fields in pipes and exposed to the weather. In the course of the ageing process which followed, the organic matter slowly decomposed to form humus which retained moisture in the dry season and provided an abode for soil micro-organisms. Nutrients such as nitrogen, phosphorous and potassium also contributed towards soil fertility. It has, however, been found that weather conditions play an important role in this process and only porous soils permit aeration and stimulate the growth of soil micro-organisms. If too much sewage is used, the soil becomes exposed to the danger of sludging or poisoning commonly known as 'soil sickness'. The sewage of 100 people per hectare (2.47 acre) has been found to be the optimum amount for sandy soils in Germany (2). The danger of bacterial infection and persistent odour makes green manuring unsuitable for the cultivation of vegetables. Cultivation of albumin-rich crops has given promising results and the protein content of hay, grown on land treated in this way, is reported to be much higher than that of hay grown on untreated land. Subrahmanian has found that sugarcane responds well to raw sewage but technological implications of the increase of non-sugars in canes have yet to be investigated. Owing to the unhygienic nature of such manuring and the limited types of soils which respond to it, this method has not been widely accepted. Moreover, the nitrogen occurs in organic form and is only partly available to crops. The distribution system requires laying of costly pipe lines and pumping stations, and absorbs a large capital.

The natural biological processes involved in the self-purification process can be stimulated by artificial means. For this purpose numerous bacteria, aerobic and anaerobic, already present in sewage are made use of. While aerobic fermentation converts organic matter into carbon dioxide and water, anaerobic fermentation produces methane and carbon dioxide to the extent of about 95%, of which about 70% is methane. The remaining 5% consists of hydrogen, sulphuretted hydrogen, and traces of oxgen and nitrogen. After purification, this gas may be used for heating fermentation chambers, generation of power and propulsion of motor vehicles. The evolution of low weight, high pressure alloy cylinders has enabled the use of this gas as petrol substitute. One cubic meter of the gas is equivalent to 1 liter of petrol. It has been estimated that 4-5 per cent of Germany's petrol requirement could be met from this source.

Anaerobic fermentation is decidedly cheaper than aerobic. It is carried out in closed chambers maintained at optimum temperature and provided with exit pipes for gases. The final effluents still contain considerable amount of organic matter and have unpleasant colour and odour. It should be further refined by aerobic fermentation before discharging into streams. Two types of processes are usually followed for this purpose—(*i*) trickle filters and (*ii*) tanks provided with air diffusion (activated sludge process). The former requires a large capital and low recurring expenditure while the reverse is the case with the latter. The final effluents in both cases have low colour, odour and pollution load. The general trend of opinion seems to be in favour of the trickle filter process. The final effluents are chlorinated and discharged into the irrigation system. There is however strong prejudice against this effluent being led into the canal water. For this reason, a closed system has been developed, in which the soluble organic matter is coagulated with the help of chemicals and after settling, the final effluent is reused in the fermentation process. The sludge obtained from the aerobic fermentation process consists largely of bacterial protoplasm and has high nutritive value as manure. The water content (about 85%) is lowered to about 50% by dehydration before putting it in the market as manure. This biological decomposition has provided a hygienic method for the disposal of sewage, combined with its utilization for agricultural purposes. Simultaneously a part of the calorific value can be utilized for industrial purposes in the form of fuel gases.

All organic matter, whatever its nature, can be decomposed by biological processes, although the composition of the products will depend on the nature of the organic matter and on the process of fermentation. Industrial effluents carrying organic matter can therefore be mixed with sewage after adjustment of pH and then subjected to biological treatment. Effluents from textile mills, tanneries, slaughter houses and organic chemical industries may be treated in this way before their final discharge into the river system (6). Disinfectants must be highly diluted before mixing them up with sewage.

UTILIZATION OF OTHER INDUSTRIAL WASTES

Coal Wastes

It is well known that India has practically unlimited reserve of low grade coals but those with more than 25% ash content are usually regarded as unworkable. Large quantities of coal dusts which accumulate at pitheads do not find adequate use. Pressure combustion of powdered coal, development of slag-trap furnaces for boilers and introduction of washing processes have opened up new possibilities of economic exploitation of high-ash coals and have created a new demand for waste coal dust. Considerable quantities of these 'dusts' accumulated at pit-heads, are carried away by rain water into low lands and streams. This loss can be controlled by collecting the water in ponds, where the coal particles are settled before leading the clear overflow water into the streams. The colloidal sludge collected in coal washing plants is rich in organic matter and trace elements, and is reported to be highly suitable for amelioration of soils and control of difficiency diseases in plants.

The ash content of coal constitutes a huge waste for which no satisfactory use has yet been found. The principal components of the ash—silica, alumina and ferric oxide—account for 80-90% while other constituents—lime, magnesia, oxides of manganese and alkali metals together with some sulphate and phosphate radicals account for another 7-15%. This leaves a difference of 2-3 per cent, which is accounted for by a large number of elements present in very small amounts. These elements may be classified as follows:—

(*a*) Rare metals, *e.g.* beryllium, germanium, zirconium, gallium etc.

(*b*) Trace elements, *e.g.* copper, nickel, cobalt, vanadium, molybdenum etc.

(*c*) Precious metals, *e.g.* gold, silver, platinum etc.

These elements owe their origin to the plant life which sucks them up from the soil and thereby concentrates them to a considerable extent. In the natural process of decomposition involved in the formation of coal, these elements are further concentrated in coal deposits. In the process of combustion of coal, they are still further concentrated, giving rise to appreciable amounts in the ash residues. Mukherjee and Dutt (20) have subjected Indian coal ash from different sources to spectrographic analysis and detected the presence in appreciable amounts of several of these elements. According to the authors, 0.1% germanium is present in the ash of Garro Hill coals, which is considered to be one of the best tapping sources for the extraction of germanium in India. It is however doubtful if exploitation of only one element, however valuable, from coal ash would prove economically feasible. For this purpose, total explotation should be aimed at, extracting not only the valuable metals but also utilizing the residues to the best possible advantage. It should be possible to effect magnetic separation of iron oxide in the ash and to convert the residual matter, mixed with limestone, into cement. Such a process of total exploitation will however have to await the solution of technical difficulties involved in the metallurgy of low grade materials.

The by-products of the coal carbonisation and tar distillation industries are too well known to need any mention here. Nor is it intended to deal with synthetic oil made from coal, inspite of its importance for the preparation of a wide variety of chemicals and other products.

Metallurgical Wastes

Modern metallurgical methods have enabled exploitation of low grade ores on the one hand and reduction of slag and flue losses on the other. Two processes for the dressing of ores have met with particular success, *e.g.*, (*i*) sink-and-float-process and (*ii*) flotation process. The flotation method is used to-day in widely different fields. It has been used for the recovery of gold that has escaped the cyanide process, for the working of lead and zinc slimes, for the concentration of copper in low grade ores, for the recovery of molybdenum ores and for several other purposes.

Introduction of improved methods of metallurgy have resulted in the utilization of low grade materials. In Europe, large number of abundoned mines whose working was regarded as unprofitable, has been reopened and is now working successfully. Residues from dressing and smelting processes, which were dumped into waste heaps, are now re-exploited and large quantities of metals are recovered from them. Thus zinc ores containing pyrites and bauxite rich in iron are charged in ordinary blast furnace and in the case of the former, zinc is recovered from flue dust and in the case of the latter, the presence of aluminium makes the slag suitable for high grade cement. The use of iron ore containing only 30% or even less of iron, for the production of pig iron and of clay, for the production of metallic aluminium, are other instances of the use of low grade materials in modern metallurgy.

Cooling of smelter gases and introduction of Cottrell precipitators have led to the recovery of many important by-products from smelting furnaces. The nature and quantity of these by-products depend on the nature and degree of impurities present in the ore. Reference has already been made to the recovery of sulphur. Arsenic and cadmium have been recovered in large amounts from flue dust in the smelting of copper and zinc ores. The use of the flue dust separated by the electrostatic methods, depends on its chemical composition. Many other elements such as bismuth, antimony, vanadium and selenium have been obtained from it. Flue dust from blast furnaces and cement works have been sent back into the process and reused after appropriate treatment. There is increasing tendency to use the wet electrolytic process for the production of zinc. This process also enables better recovery of associated metals which are present in the sludge and may be recovered from it. Mention may also be made of the 'red mud' which separates in the purification of bauxite by the Bayer Process and accumulates in large quantities in aluminium factories. In India, this mud is particularly rich in titanium whose extraction has been studied by several investigators (14).

Slag:

Vast quantities of slag are produced in ferrous and nonferrous metallurgy. Roughly speaking, for the production of every ton of pig iron, there is half a ton of slag produced. Proper utilization of these slags is an important problem and attempts in that direction have been only partly successful. Slag wool has ben produced by injecting steam into the molten mass and this wool has been extensively used for house insulation, refrigeration, air-conditioning and other industrial purposes. Larger cement works have also used the slag for the production of portland cement. Slags containing phosphorus have been found useful for soil amelioration. In addition it has been used for the building of roads, manufacture of concrete and as rail-road ballast. In U. S. A., all these uses consume only 40% of the total production of slags (1938), the rest are evidently dumped near the works or thrown into the sea.

The slags of non-ferrous industries are used for similar purposes. Slag heaps of medieval period carry considerable amount of metals.

Slags carrying lead and zinc in appreciable quantity are now treated in specially designed furnaces where the metals are vaporised and recovered. It is surprising to note that slag heaps, found in Southern Spain and attributed to the smelting of copper ores by the Romans, are very low in copper content. It is believed that the Romans used considerable quantity of salt during the smelting operation, but kept the process secret. Subsequent generations, therefore, could not make use of this knowledge.

Pickle Liquor

Modern processes of galvanising, tinning, enamelling and electroplating demand thoroughly clean surfaces, so that the covering material will form a continuous and uniform protective coating.The special needs of these industries have given rise to modifications of rolling mill practice, requiring thorough cleaning of the surfaces of rolled goods. This cleaning or "Pickling" is generally done with sulphuric acid, though hydrochloric and other acids are used in special cases, particularly with alloy steels. The acid is repeatedly used until practically exhausted. Composition of pickle liquor varies to a great extent according to the practice adopted, but may be taken on an average to contain 1—4%free sulphuric acid and 15% ferrous sulphate. Quantity involved is very large; in U. S. A., it amounts to 500-800 mill. gallons per annum. The discharge of this huge quantity into the streams not only depletes the water of its oxygen content, but the acidity of the water constitutes a danger to navigating vessels and industrial equipments. The iron and steel industry have spent large sums of money in promoting research to find out suitable methods of its utilization. Those efforts have been further stimulated by the work of the Mellon Institute. Although great progress has been achieved and the problem seems well on the road to solution, all efforts of scientists have so far foundered against the hard rock of economy. The comparatively high cost of equipment required for treating large quantities of the corrosive material and lack of adequate markets for most of the byproducts are important factors which have baffled the scientists, although a large number of processes (13) have been developed in recent years. The most important of these methods aim at the recovery of ferrous sulphate (copperas) and iron oxide. A new use of chlorinated copperas as an efficient coagulant for sewage and industrial effluents promises to create a large demand for it.

Pulp and Paper Industry Wastes

Raw materials used in the production of pulp and paper generally contain only 50% of recoverable cellulosic materials, the rest consisting of lignin, carbohydrates and other organic substances have to be removed in the process of manufacture. In addition considerable amounts of valuable fibrous material are carried away by the large quantity of water used in paper mills. These waste materials are often discharged into rivers and become a serious source of pollution. Researches for the utilization of these waste materials have been financed liberally both by the industry and the state in western countries. Though many interesting products have been obtained, the market of these products is inadequate and hence recovery processes have not yet found general acceptance. Important results may however be expected in not too distant future.

The most important contribution in this field is the Howard process (21) which consists of fractional precipitation of waste sulphite liquor by treatment with lime. Three primary products are thus obtained; the first fraction, consisting of calcium sulphite, recovers valuable sulphur for reuse in the process, the second fraction is the basic salt of lignosulphuric acid and as sodium or magneseum salt, may be used for tanning leather, softening water or as dispersion agent. Considerable amount of vanillin is also made by alkaline hydrolysis. The third fraction, carrying carbohydrate and other organic matters, is discharged as effluent. Recently, one of the products of lignin utilization, ethyl vanillate, has been found to be a very efficient food preservative without any toxic effect in concentrations used on persons consuming it.

Fermentation of the waste sulphite liquor into alcohol has been practised in Germany and Scandinavia where the price of alcohol is high. This process, however, utilizes only a part of the carbohyrates, the other part, present as pentoses, being unfermentable. The culture of food yeast seems a more promising proposition as the yeast consumes both pentoses and hexoses during growth.

In certain plants magnesium bisulphite is used for the cooking process. In such cases, the waste liquor is concentrated to about 45% solid content, when it can be burnt in boilers, utilizing the fuel value of the organic matter and recovering magnesium oxide for re-use in the process. This process of utilization has not been found suitable for calcium bisulphite liquor. The waste black liquor' of the sulphate process may be similarly concentrated and burnt, recovering terpentine and dimethylsulphide from the gases and the alkali from the ash.

It is well know that large quantities of water used in the paper machine, carry away the fibre and other ingredients used in paper manufacture. These ingredients consist of sizing and colouring materials, fillers and adhesives, and the effluent is commonly known as 'white water'. Various pulp saving devices called 'save-alls' have been developed to recover the fibre and other solid ingredients. Amongst the processes used for this purpose are: (*a*) Seiving through fine mesh wire screens, (*b*) filtering through cloth or pulp and (*c*) sedimentation or flotation. The most outstanding discovery for this purpose is the development of closed system, in which all the materials are fully recovered with practically no loss (9). It is now regarded as unnecessary to separate the fibres and other ingredients from water. Modern recovery system recirculates the white water into the process without separation of components—thereby producing a closed system with practically no loss. Formerly the loss of fibre was as high as 15-20%; this loss was considerably lowered by the provision of "save-alls"; the introduction of the 'closed system' has lowered the fibre loss to below 1% with complete utilization of other ingredients.

Forest Wastes

Utilization of vast quantities of forest wastes and other cellulosic wastes is an important problem and for many years, researches were directed to evolve better methods for the utilization of inferior wood, saw dust, bagasse, straw and other fibrous materials. Distillation with the production of charcoal and various byproducts has only limited application. During the war, charcoal was converted into producer gas which was used as a substitute for petrol in the propulsion of motor vehicles. For this purpose 2.5 kg waste wood gave a gas equivalent to 1 liter of petrol. With the establishment of normal conditions, this practice has disappeared. In several countries, wood wastes have been hydrolysed to yield animal fodder and sugar. This sugar may be used for the manufacture of power alcohol and for the cultivation of yeast. This latter industry deserves special notice as it supplies vitamin-rich concentrated protein food. Cultivation of yeast also consumes both fermentable and non-fermentable sugars produced by wood hydrolysis.

Low grade cellulosic materials have been used for the manufacture of high class fibre board. The pulp obtained by cooking wood wastes is compressed at extremely high pressures with the addition of a binder, usually a synthetic resin. The hard board thus produced does not shrink, may be made waterproof and fireproof, and is used for door panels, flooring and the like. An important development is the manufacture of parts of prefabricated houses by incorporation of these fibrous materials with cement. Standard size building blocks made of rice hulls, saw dust and portland cement have been placed in the market. They are reported to withstand high pressure, are impervious to water, can be sawed and hold nail without difficulty.

DISPOSAL OF INDUSTRIAL WASTES

The above instances of waste utilization have been chosen rather arbitrarily and do not necessarily represent the most important ones. Numerous other instances could be cited but seem unncessary, as my object is not to give an exhaustive review but to draw attention to the importance of the utilization problem. Methods of disposal of industrial wastes are no less important. Stress has been laid on utilization processes, not merely because of their inherent importance for national economy, but mainly because such recovery processes are integral parts of operations to deprive waste materials of their obnoxious character. Unless recovery is effected, the materials will have to be discharged into the air or water, giving rise to serious pollution problems. Moreover, such utilization also meets a part, if not the whole of cost of disposal and frequently brings profit. It is unfortunate that mere humanitarian considerations often fail to induce industrial management to undertake elaborate and costly processes of disposal. The realisation that waste materials are responsible for extensive damages to industrial machinery focussed attention on the problem of their harmless disposal. But it was only when the evidence came, that recovery processes would not only cover a substantial part of the cost but might actually bring profit, that economic and humanitarian considerations combined to promote hygienic disposal of wastes. But profit or no profit, utilization or no utilization, these wastes must never be permitted to pollute the air we breathe and the water we drink.

Atmospheric Pollution

Abnormal concentration of any kind of matter—gaseous, solid or liquid—in the air at the ground level may be taken as an indication of pollution. Such pollution is usually caused by gases, vapours and suspensions of solid and liquid particles. Some of these materials are toxic, some offensive and some injurious to life and property. If the concentration of these materials fall below a certain level, they become harmless. It is only when the concentration rises above this limiting value, that their presence becomes a danger to society. It is therefore necessary to ascertain this limiting or threshold concentration for different gases, vapours and dusts, and to discharge them in the atmosphere in such a manner that their ground level concentration does not exceed the limiting figure. If they could be discharged into air streams which did not come to earth, the problem would be alleviated and for this reason high chimneys are an advantage. The subcommittee of the Electricity Commissioners in U.K. (1932) reported that "Emissions from chimneys having a height 2½ times that of surrounding buildings, plus where necessary, the additional height to compensate for the contour of the adjacent land, will discharge into air streams which can be depended upon not to come into contact with the earth under normal conditions" (22).

Meteorology can be of great help in locating the most effective air currents which do not normally come to earth and in suggesting most suitable site for a new plant and appropriate height of the chimney so that the contaminats may be discharged in the air current.

The mass rate of emission of offending gases from the chimney has been found to be of fundamental importance (16). The maximum permissible rate for such emissions has to be specified and its relation to ground level concentration found out. This relation has been mathematically deduced and is given by the following formula:

$$C_o = \frac{1.55 \times 10^3 \ M}{vh^2}$$

where C_o is the ground level concentration (mg per cu. meter) of the contaminant, located at a distance of 10 chimney heights, 'h' is the height of the chimney (meters), M the mass rate of emission (metric tons per day) and 'v' the wind velocity (meters per sec.) (17).

Gases: Of the various objectionable gases, the damage caused by sulphur dioxide is perhaps the most extensive. Its corroding property in the presence of moisture is well known. When inhaled, it irritates the mucous membranes in the throat and causes violent coughing; the effect on people suffering from respiratory troubles may be disastrous. It has also great injurious effect on vegetable life at concentrations above 1 p.p.m. Combustion of coals containing sulphur is responsible for its generation. Fortunately Indian coals, with the exception of Assam and a few other varieties, are poor in sulphur content. Methods for the removal of sulphur dioxide from smelter and flue gases have already been discussed and are, generally speaking, quite efficient. Scrubbing operations may bring down the sulphur dioxide content to as low as .5—.75 p.p.m. Where the scrubbing operation is not practicable, the gas is discharged at a safe height in an inoffensive manner.

Sulphuretted hydrogen is detectable by its characteristic odour even in the concentration of 0.34 p.p.m. It is highly toxic to animals. Organic sulphurous gases such as carbon dispulphide, mercaptans, alkyl sulphides are also toxic and obnoxious. They are usually removed by scrubbing and adsorption processes. If present in small amounts, a more effective way is to burn them into sulphur dioxide. Another toxic gas, carbon monoxide, owes its presence to inefficiency *i.e.,* to defective combustion or to leakages in the system. Modern industrial practice has almost completely eliminated this nuisance. Acid fumes, chlorine and other toxic gases have to be treated at the source, usually by the scrubbing process. Alkalies have often to be added in order to control pH and corrosion. In the case of sulphur trioxide, electrostatic separation is widely used.

Vapour:

Offensive vapours are sometimes generated in considerable amounts in the course of industrial operations such as distillation of petroleum, extraction by volatile solvents, and various other processes involving chemical reactions. Climatic conditions and inefficient operations aggravate this nuisance and enhance the risk of fire and explosions. The effect of continuous inhalation on operatives may be serious. Appropriate measures at the source are possibly the best means for checking these contaminants. Such measures differ according to the nature and concentration of the vapour. Proper ventilation, prevention of leakages, use of scrubbing and adsorption processes followed by subsequent recovery are the most effective methods in dealing with them. Where scrubbing or recovery processes are not practicable, the vapours are either burnt or the scrubbing liquor is discharged into river. In the latter case, the atmospheric pollutant is merely transferred to stream water.

Dust and Smoke:

Considerable amount of fine particles is discharged into the atmosphere from industrial operations such as the following:—

(*a*) Power generating plants, using high ash coal and discharging the same as fly ash.
(*b*) Smelting operations, carrying fine particles into the flues.
(*c*) Cement works, using finely ground materials in rotary furnaces.
(*d*) Vehicular traffic, generating dusts from roads.

The nuisance value of these dusts is well known. Soiling of clothes, dirtying the rooms and furniture are constant sources of irritation in larger towns. Greater incidence of lung diseases in cities and industrial areas shows that the effect of smoke and dust on human health cannot be ignored.

There are numerous devices for dealing with the industrial dust problem, of which the following may be specially mentioned:

(*i*) Electrical precipitation (Cottrell process),
(*ii*) Washing of gases (scrubbing and spraying)
(*iii*) Centrifugal precipitation,
(*iv*) Cloth filtration, settling chambers etc.

The electrical precipitation is the only system which gives uniformly good result with both corrosive and non-corrosive gases, but this process is a costly one and hence not acceptable to smaller industries. The wet washing systems have attained a high standard of efficiency but are corrosive in the presence of acidic gases. Dry types of dust collectors, such as the centrifugal system, have rather low performance when the discharge rate is high. Waste sulphite liquor, when concentrated or evaporated to dryness, has adhesive property and when dissolved in water and sprayed on roads, is reported to have given satisfactory results for the control of dusts.

The smoke problem (23, 18) is more difficult to deal with, specially when clouds of smoke emanate at a low level from numerous kitchen windows or brick kilns. An improved and generally acceptable device for the kindling of domestic coke is an urgent necessity in this country. Improved methods of combustion and high chimneys have effectively eliminated this nuisance in modern industrial furnaces.

Water Pollution

Rivers and streams are capable of immense good or evil according to the use or misuse we make of them. The purity of our domestic and industrial water is of vital importance. Our water ways must be safe for navigating vessels and harmless for aquatic life and agricultural use. Great care and judgment are necessary to keep the water reasonably pure. Organic matter, suspended particles, acids, alkalies and salts are the usual contaminants. The organic matter is perhaps the worst offender. It absorbs oxygen from the water and thus reduces the oxygen content. The rate of reduction of oxygen is generally greater than the rate of its increase by absorption from the air. When the oxygen content falls below 4 p.p.m., water becomes unfit for drinking and when it falls below 2 p.p.m., aquatic life is generally suffocated. The fall of oxygen content is also associated with the appearance of other offensive conditions such as colour, odour and taste. For these reasons biochemical oxygen demand (B. O. D.) is taken as a measure of pollution. Of the chemical methods, the chromic acid wet combustion method gives more reliable results than the oxygen consumption determined by the concentrated permanganate method (24).

The suspended matter gradually settles to the bottom and when organic in nature, ferments under anaerobic conditions prevailing at river beds and is often carried mechanically to the surface with the bubbles of gases evolved in the process. When the particles are finely dispersed, they cause opalescence and are sometimes responsible for the clogging of filter beds. In such cases, chemical coagulation is often resorted to. Acid water causes corrosion and is dangerous to navigating vessels and industrial equipments. Acids also suppress bacterial growth and thus retard the 'self-purification' process. Alkalies and salts cause colour and taste, and are toxic to aquatic and plant life. Phenols are also toxic and responsible for taste in drinking water, which aggravates with chlorination due to the formation of p-chlorophenol.

The worst contaminants are sewage and industrial effluents. The B. O. D. of industrial effluents in certain areas may even be higher than the B. O. D. of the sewage of a small town. Distillation residues in fermentation industry, jute retting effluents of paper and pulp, tanning, soap, chemical and pharmaceutical industries are made up largely of organic matter and suspended particles. Coal mines, steel and associated industries and petroleum industry discharge considerable quantities of acids and salts. The character and composition of the effluents of each industry differ from the other and the alleviating measures, which must be based on the quantitative and qualitative composition of each effluent, must necessarily be different. Frequently, the discharge from two sections of the same industry differs considerably in character and concentration. Principles of chemistry and chemical engineering play an increasingly inportant role in devising satisfactory measures of control.

Rapid Progress of Control Measures:

The capacity of a stream for 'self-purification' depends on the volume and rate of flow of its water, which vary greatly according to season and contour of the locality. The self-purification capacity is also related to the character and quantity of effluents discharged into the stream and should be studied with special reference to these factors. One of the cheapest and most efficient methods of treatment is to mix industrial effluents of organic nature, after proper dilution and adjustment of pH with sewage and subject the mixture to biological treatment. The effluents of anaerobic fermentation have high B. O. D., colour and odour, due obviously to the presence of organic matter in dissolved state. These effluents must therefore be stabilised by further 'aerobic' fermentation in trickle filters or activated sludge tanks.

The chemical and physical methods of control are based on the properties of various discharges. These methods consist of separation of effluents according to concentration and character, adjustment of pH, sedimentation, aeration, coagulation, filtration and chlorination. Lime and sulphuric acid are commonly used for adjustment of acidity or alkalinity ; ponding or storage tanks for sedimentation; ferric sulphate, alum and chlorinated copperas for coagulation and sand and other porous beds for filtration.

Methods of control are constantly undergoing modification and improvement. The scrubbing methods of removing objectionable ingredients have been partly replaced by the use of adsorbents, usually activated carbon. Introduction of ion exchange materials, capable of quick regeneration by the simple process of washing, has brought simplification and economy in water softening processes. The recent discovery of amberlite resins, some of which have ion exchange properties under a wide range of pH and dilution, has opened up new possibilities not only for water refining but also for recovery of metallic elements from various industrial effluents. Introduction of the flotation method for the recovery of many useful fibrous and other materials from suspensions constitutes a substantial improvement over older methods and combines antipollution measures with economic recovery. Reference has already been made to the development of the 'closed system' in paper and other industries, which is an excellent example of the combination of full recovery of waste materials with almost complete prevention of pollution. The most satisfactory methods are those which attack the contaminants at the source, recovering them for useful purposes where-ever possible, or destroying them where-ever necessary.

THE NEED FOR A NATIONAL PROGRAMME

Standing on the threshold of industrialisation, it is time for us to reflect on the raw material position on the one hand and possible evil consequences of industrialisation on the other. Only then shall we be able to devise and take appropriate measures for remedy. Our shortage of sulphur and some essential minerals is well known. We do not yet produce some important chemicals which we badly need. At least some of these materials can be recovered in substantial amounts from industrial wastes. We are throwing away some valuable potential fertilisers which we urgently need to increase our food production. We can, at least partly, meet our shortage of building materials by utilising various waste products which we do not use, or at best, use only as fuels. Are we entitled to pollute the air and water, and thus endanger public health and happiness? Can we afford to be indolent? The answer to these questions is obvious. The main difficulty is,—we do not know what is to be done and how to do it. Fortunately, experience of the West can give us some clue to these problems.

The first essential pre-requisite is knowledge. At present we lack knowledge of the character and quantity of wastes discharged individually and collectively by different industries. We do not know the methods of control and reclamation, and lack fundamental data upon which these methods are to be based. An expert committee must survey which of these methods, under conditions prevailing in this country, may be remunerative, which may 'break even', and which may be suitable only for the abatement of pollution. The capacity of streams for dilution and self-purification in different seasons has to be investigated. Samples of water and air, collected at different distances from the source of contamination, have to be analysed and the results co-ordinated. We do not know the minimum permissible limit of different contaminants and the setting up of an authoritative body whose opinion in this matter may be relied upon is an urgent necessity.

In Europe and America, the necessary information is collected by high level commissions, committees and research organisations set up by the State and the Industry. In England, the Royal Commission on River Pollution, the Royal Commission on Sewage Disposal and the Standing Committee on River Pollution (25) have exhaustively reviewed the position and the Research Institute on River Pollution is doing valuable work in collecting fundamental data,—an essential prerequisite for corrective measures. In U.S.A. the federal government, the states and the industries are each tackling the problem in their own spheres. The Special Advisory Committee on Water Pollution of the National Resources Committee surveyed in detail the existing position in U.S.A. (26). Under the auspices of the Public Health Department, a research organisation known as the 'Water and Sanitary Investigation Station' has been set up at Cincinati. In addition, the famous Mellon Institute, the M.I.T. Sanitary Laboratory and the University of North Carolina are carrying on fundamental investigations on utilization and pollution problems. In 1946, the American Public Health Association set up a Committee on Sewage Disposal. Industrial organisations are also contributing liberally to the solution of the problem. Mention any be made of the researches directed to the waste utilisation and disposal problems carried out under the auspices of the Iron and Steel Industries, Mineral Oil Industry (Philadelphia), Textile Foundation (Princeton) and Paper and Pulp Industry (Appleton). The co-operative efforts of the Paper and pulp Industries have led to the establishment of the National Council for Stream Improvement which has been functioning since 1944.

The second important requirement is the settling up of an administrative authority vested with adequate power to promote and control waste treatment. The Government of the country, responsible for its industrial policy, cannot dissociate itself from the consequences of the policy. Public health and welfare are vitally involved. The task cannot be left to individual initiative. Considering the nature and magnitude of the problem, effective action has to be based on close co-operation of the Centre, Provinces, Municipalities and Industries. A programme of work on national lines can be drawn up only by the combined efforts of men of knowledge in widely different fields—scientists, technicians, administrators and financiers. Would an existing or reorganised department of the Government be competent to undertake the task with reasonable chance of success? Or would it be more desirable to set up a separate organisation for the purpose similar to the Allegheny County Sanitary Authority in U.S.A.? What would be the constitution, scope and functions of such an organisation? How should a government department be reorganised, if it is decided in favour of such a course? How are the researches and control measures to be financed?

Only a National Committee, similar to the Royal Commission in England and National Resources Committee in U.S.A. can find satisfactory answers to these questions. The constitution of a National Committee in this country must not be postponed indefinitely. We have a duty to society. We can shirk taking action for some years, but we cannot shirk the consequences.

REFERENCES.

1. Baehr—*Chem. Fab.*, 11, 10-20 (1938).
2. Ungewitter—*"Science & Salvage"* (Trans. by Fermey & Haim, 1944).
3. Gollmar—*Ind. Eng. Chem., 39,* 596-601 (1947).
4. Leithe—*Bren-stoff. Chem., 22,* 49-57 (1941).
5. Chowdhury & Dutta—*J. Ind. Chem. Soc., 20,* 253-60 (1943).
6. Eldridge—*"Ind. Waste Treatment Practice"* (1942).
7. Powell—*Ind. Eng. Chem, 31,* 789-96 (1939) Gollmar, *ibid, 26,* 130-32, (1934).
8. Lorenzen—*Chem. Feb. 12,* 6-23 (1939), Bahr, *ibid, 11,* 283-92 (1938).
9. Warrick—*Ind. Eng. Chem., 39,* 670-76 (1947).
10. Candall—*Chem. Met. Eng., 34,* 143-47 (1927).
11. Rosener—*Chem. Fab. 10,* 101-6 (1937).
12. Chowdhury & Hossain—*J. Ind. Chem., Soc., 8,* 81-93 (1945), Sen & Das-Gupta *ibid, 11,* 71-76 (1948).
13. Hodge, *Ind. Eng. Chem., 31,* 1364-79 (1939), Hoak, *ibid, 39,* 614-18, (1947).
14. Das-Gupta & Das-Gupta—*J. Ind. Chem. Soc.,* (*Ind. News*), *4,* 16-20, (1941); Mehta & Purmahamed—*ibid, 8,* 9-14, (1945).
15. Tripp., *J. S. C. I.,—58T,* 1102-4 (1939).
16. Bonsanquet & Pearson—*Trans. Farad. Soc. 32,* 1249-64, (1936).
17. Hemeon & Hatch—*Ind. Eng. Chem., 39,* 570, (1947).
18. Nonhebel—*Trans. Farad. Soc., 32* 1291, (1936), Owens, *ibid, 32,* 1234, (1936).
19. Siecke—*Chem. Fab., 8,* 415, (1935).
20. Mukherjee & Dutta—*Science & Culture, 14,* 538, (1949); *14,* 213, (1948).
21. Howard—*Ind. Eng. Chem., 22,* 614-17 (1934).
22. Monkhouse—*Chem. & Ind., 58,* 596-600 (1939).
23. Gray & Peterson—*"Smoke",* Arnold, (1932).
24. *"Standard methods of Exam of Water and Sewage"*—publ. jointly by Amer. Public Health and Water Works Assns. New York (1946).
25. (*i*) Royal Commission on River Pollution, 1st. Comm.—*3 rpts.* (1865-68), 2nd Comm. *5 rpts.* (1863-74. London, H. M. Stationery office.
    (*ii*) Royal Comm. on Sewage Disposal—*9 rpts,* (1901-15). London.
    (*iii*) Standing Committee on River Pollution, (Br. Ministry of Agri. & Fisheries), *4 rpts.* (1921-27), London, H. M. Stationary office.
26. National Resources Committee—*3rd Rpt.* of Special Advisory Committee on Water Pollution, Washington D.C. (1939).

37th INDIAN SCIENCE CONGRESS, POONA, 1950

SECTION OF GEOLOGY AND GEOGRAPHY

PRESIDENT: J. COATES A.R.S.M. F.G.S. F.N.I. F.Inst.Pet.

Presidential Address.

THE PROGRESS OF OIL PROSPECTING IN THE INDIAN UNION

INTRODUCTION

It is a very special occasion in one's professional life to be invited to be the President of a Section in the Indian Science Congress, and I must thank you very much for the great honour you have done me. I feel this the more deeply because a geologist engaged in the economic applications of the science is very conscious of his shortcomings compared with the knowledge of his colleagues in the Academic sphere and the Government Geological Survey.

2. Before I go further, I am sure that you would wish me to make a brief reference to the passing this year of two men of science who were specially connected with this Section. In April there came the tragic and unexpected loss of Professor Birbal Sahni, who although best known as a famous Botanist, was President of this Section in 1926, and was particularly interested in the geological bearing of his researches, and a personal friend of many of the geologists here today. Later in the year came the news of the passing of Sir Edwin Pascoe, Director of the Geological Survey of India from 1921 to 1932, and still engaged on a professional work of great importance to us all. I would ask you to recall with gratitude the work which these men have done for the furtherance of science in India, and to stand for a few moments in silence in their honour.

3. Now that so much effort is being devoted to planning and carrying out great schemes which represent the application of science to practical affairs, no apology is probably needed for selecting, as the subject of this Address, a topic which is not purely of academic interest but in which the theoretical and the practical are interwoven quite inextricably. It is no longer regarded as any debasement of science to turn it to the affairs of everyday life ; rather does one thus obtain a widened field of investigation, and the stimulus of having to test one's hypotheses by experiments on a grand scale.

4. In giving this account of the progress of prospecting for Petroleum in the Indian Union, I want to combine two main objectives : firstly, to present a general historical record (of which no convenient summary has recently been made), and secondly, to use this story to illustrate the development of oil-finding technique and the progressive application of scientific methods in what was initially an almost wholly empirical art.

5. Oil Prospecting in India is a very suitable topic for such a combination, because the drilling of wells for oil on the modern basis started in India very soon indeed after its first beginning in the U. S. A. The date of the Drake well in Pennsylvania, 1859, is usually taken as the beginning of the modern oil industry ; and by 1866 there were wells drilling for oil in Assam. So the story of oil prospecting in India will be found to represent all stages in the development of the subject.

HISTORICAL SEQUENCE OF PROSPECTING

6. When Oil Prospecting started in the Indian Union it was so early in the development of the industry that prospecting was purely empirical and no reasoned hypotheses had been developed. The prospector looked round for the evidence of surface seepages of petroleum, set up his outfit on the nearest convenient spot, and went on drilling until it became mechanically impossible to drill any deeper, unless he struck oil first.

7. This procedure was (in spite of many failures) giving quite encouraging results in America, and the general outlook in India seemed reasonably comparable. There were belts of ground in which oil seepages were plentiful, and they lay geographically between the similar oil seepages of the Punjab-Baluchistan area and the hand-dug well oilfield area of Burma. In 1866 and 1867 therefore some attempts were made to drill for oil in Assam near the seepages : three wells were put down at Jaipur and three at Makum. They were what we should now call very shallow, less than 200 ft., but the Drake well in Pennsylvania obtained quite good production at only 69 ft.

8. These first wells were partially successful in that they found some oil, but not enough to arouse any enthusiasm for continuing. Nevertheless, after a few years (1888 to 1893) another firm sank several more wells at Makum—getting enough oil to warrant putting up a small refinery—and started drilling also at Digboi. By this time drilling technique had improved so that several of the wells were over 500 ft. and one even passed 1000 ft., and this gave a better chance of finding an oilsand somewhere, and of obtaining enough oil to make the venture remunerative.

9. As we now know, operations on these lines are very likely to find a little oil but relatively unlikely to find a great deal ; and they have the great drawback that any degree of failure leads to no suggestion about what might be done to improve the position—except to drill a bit deeper, or to try again somewhere else. These Assam Wells were fairly true to type.

10. The reasons for this are easy to understand. The surface seepages owe their existence to the outcropping of an oilsand or to the proximity of a fault which forms a channel for the escape of oil from a lower level. Unless there is some sealed-in reservoir present, such as a porous bed capped by an impermeable clay (and this would probably come at some rather deeper level), there is nothing to cause any concentration of the oil : except perhaps for the partial sealing effect of the waxing-up of the exposed surface by the evaporation of the escaping oil.

11. As it happens, from what we now know, the Makum sands then within reach all outcrop at the surface, and the wells had no chance of finding substantially better conditions below. At Digboi anticlinal structure does exist, but these early wells were unlikely to go deep enough to get the full benefit of it.

12. At this stage the results in the rest of the subcontinent had been discouraging ; the wells drilled by Government at Khattan in Baluchistan, and elsewhere in that region, had proved to be financial failures in spite of the initial encouragement of finding some oil ; and the Assam operators probably felt that a certain amount of caution would be wise. There followed therefore quite a long period during which nothing much was done in the way of looking for new fields, effort being concentrated on mild but persistent development of the areas where oil had actually been found.

13. By this time operators all over the world—and particularly of course in the U. S. A.—had been trying to better the results of their early prospecting and to deduce how new fields might be found through knowledge of what geological conditions give rise to oil accumulations. Two broad generalisations were made : (*a*) that oil tended to occur, in each region, in rocks of some particular geological horizon, and (*b*) that accumulation occurred in anticlines. These principles brought in the geologist as an essential specialist in oil prospecting, and opened up new possibilities of finding oil-fields even where no surface indications of oil existed.

14. So in India systematic geological mapping for oil exploration was instituted (from about 1908 onwards), and as the Geological survey of India had barely touched the Assam Tertiaries at that stage (except for reconnaissance) the work was left almost entirely to the Oil Companies. There was a tremendous area to cover, including of course in those days the region now in Pakistan, as well as the whole Tertiary belt from Assam down to Arakan ; the latter presented a peculiarly difficult problem because of the relative absence of fossils and the variable lithology of the rocks.

15. Interest was sustained in India by the continuance of production at Digboi and by the opening of the Badarpur oilfield which also conformed to current specifications of oilfield types by being anticlinal in structure. This field had actually been indicated in 1901 by a hand-dug well situated near an oil seepage and was taken up in 1910 by a syndicate ; in 1915 they passed it on to a company already producing oil in Burma, who pushed ahead with the development of Badarpur.

16. The success of these centres provided a stimulus for further effort, especially as a temporary diversion of attention to the Punjab (due to the proving of the Khaur field in 1914) was relaxed in consequence of various failures in other test wells in the Punjab and Mekran.

17. The picture that emerged from the systematic mapping of the eastern areas was roughly as shown in Plate 1. The Tertiary rocks, in which all the known oilshows occur, form a long belt in and at the edges of the chain of hills between Burma on the south and Assam, Sylhet and Chittagong on the north and west. North and west of the exposed rocks are plains of alluvium, through which the metamorphic rocks of the Shillong plateau protrude. The south-eastern parts of this Tertiary belt, running in and near the high mountain ranges, are very severely folded and thrust-faulted ; towards the north-west the intensity of the folding diminishes, until along the borders of Sylhet the folding is very gentle indeed and only beds of high horizon are exposed. In Upper Assam one sees very little of this gentle folding, the alluvium coming usually right up to the belt of moderately intense folding.

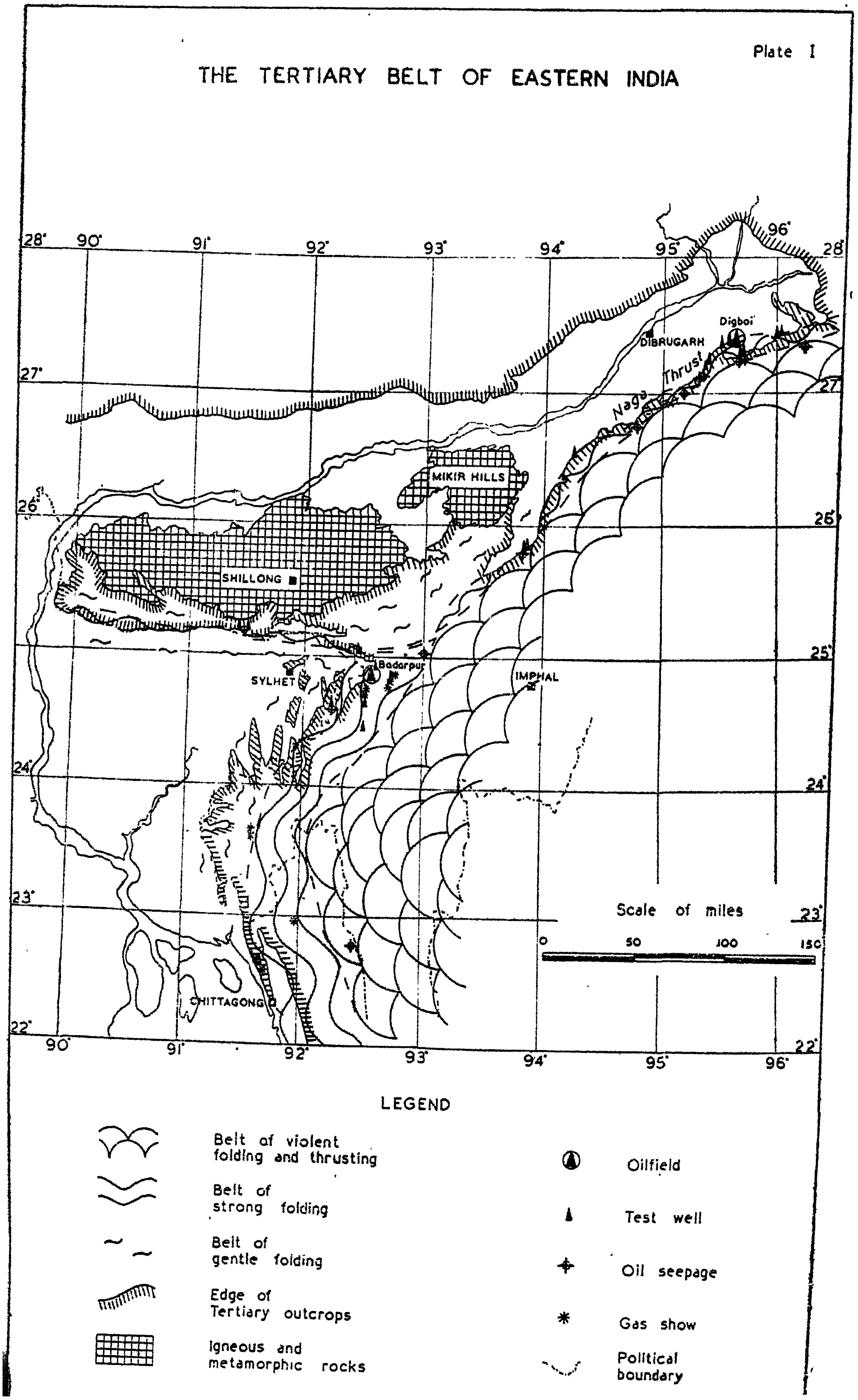


Plate I

THE TERTIARY BELT OF EASTERN INDIA

18. The oil indications follow a roughly similar graduated pattern, though not exactly parallel to the structural trends. In the belt of faulting and intense folding (and sometimes in the zone of merely strong folding) there are surface seepages of oil in fair plenty, but towards the belt of gentle folding the oil seepages cease and are replaced by shows of gas without any accompanying oil.

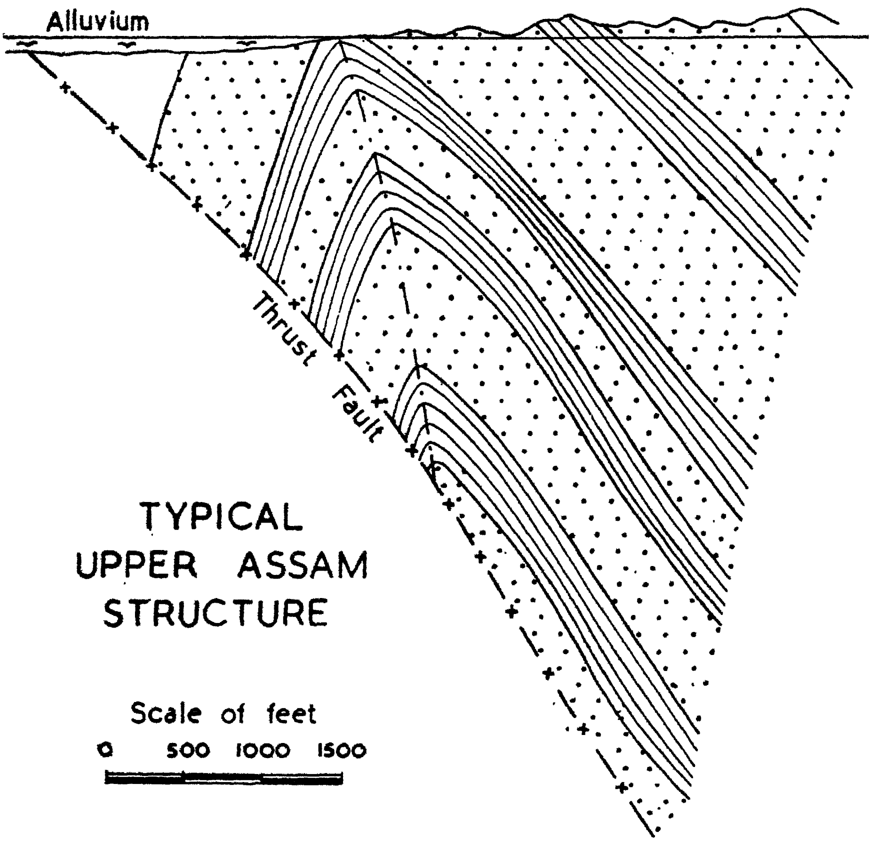
19. From the oil prospecting point of view this situation presents the difficulty of opposing factors. On the one extreme we have the assurance of the general existence of oil but the absence of suitable structures to contain it ; and on the other side we have apparently suitable structures (large and not severely faulted) but no assurance that oil-forming conditions have extended within their reach : they might be quite barren, or they might contain gas without any oil. And, further, these gentle structures are also less eroded, so that an increased thickness of rocks remains to be drilled through to reach any given horizon, and there is the added uncertainty of intervening unconformities masking the underground structure. The selection of a test-well site has therefore to balance these conflicting considerations.

20. On this basis, a number of structures in the intermediate belt were taken in hand for testing, between about 1918 and 1925 ; some in Upper Assam and some in the Surma Valley. In no case, unfortunately, was conclusive success attained, though in several of them enough doubt remained to make it worth giving them further consideration. It is instructive to analyse the reasons for this.

21. In Upper Assam the alluvium comes close up to the edge of the belt of strong folding and faulting (instead of leaving a strip of gentle folds as in the Surma Valley), and although we have the evidence of Digboi Field to show that accumulation is possible in one of these marginal overthrust folds, it is only in this frontal line (and perhaps the next line behind it) that the intensity of thrusting is likely to be low enough to leave sealed reservoirs.

22. A section through part of the Digboi field typifies the conditions in these frontal folds. The thrust fault which underlies the structure has quite a high hade, so that although near the surface there is an anticlinal fold, at some distance below the surface the thrust cuts across the axis of the fold and leaves only a monoclinal flank abutting against the fault, or even runs parallel to the flank dips so that the downward extension of the structure is quite definitely limited; below the fault are beds of very high horizon, with no indication of structure suitable for oil accumulation even if one were to drill very deep.

23. Now in different parts of these folds running parallel to the edge of the alluvium, erosion has reached various levels and the thrust comes in at different structural positions. When no anticlinal reversal remains at the level of the potential oilsands, it has been proved (as one would have suspected) that no significant oil accumulation takes place. There are several places where there is quite definite anticlinal reversal at the surface before the fault is reached, and at the beginning of testing high hopes were, naturally enough, entertained ; but in one area after another it turned out that the thrust fault had an unexpectedly high hade, so that the structure proved barren of oil on test.



24. In the Surma Valley the conditions—and the sequence of operations—were different. A variety of structures were selected for testing, all fairly near the oil indications and within range of the positive evidence of the Badapur oilfield. Wells drilled were of the order of 3000 ft. deep (which was quite a successful achievement for those days), a depth which was expected to bring them to the horizon of the oilsands of the Badarpur field. Here again, however, there was a disappointing absence of positive success in the way of proof of the existence of a potential oilfield.

25. Quite a number of factors were involved in the lack of success in these wells. For one thing, although the drilling was actually carried to about the depths intended, very considerable (and abnormal) difficulties were encountered in the way of water-sands of unusually high pressure, with gas, and shale formations which crumbled and squeezed in to the hole. This is not the place for discussing problems of this type, and it will be enough to mention that the overcoming of them, then and later, led to many very interesting developments in drilling technique, some of which represented pioneer work in scientific applications in the industry.

26. Another thing found was that the Badarpur oilsand horizon was not, after all, encountered at the expected depths, so that the correlations needed adjustment. The economic need for solving this problem, and the absence of the more usual guides of macro-fossils or distinctive lithology, led to a great deal of intensive work in the application of Heavy Mineral

Analysis—then virtually in its infancy—which has since proved of great practical value. More recently, micro-foraminiferal investigation and micro-palaeobotanical research have been directed towards the same problem.

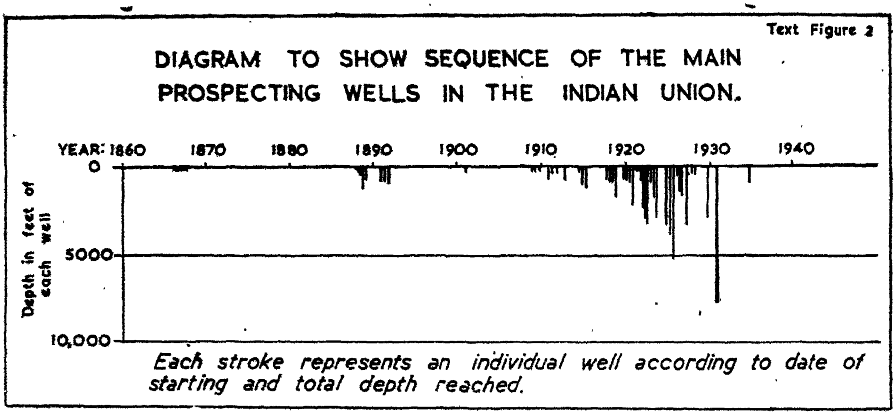
27. A further feature discovered was that the underground structures disclosed by the test-wells—according to the dips found in the cores and correlations by lithology—were not at all what had been expected from surface data. This led to a study of the technique of drawing geological sections when beds do not maintain constant thickness, amplifying the earlier work done in Burma and elsewhere by Busk and others, and this technique (summarised in an earlier paper before the Indian Science Congress) does not appear to have been applied in other countries. There has resulted a considerable improvement in the forecasting of details of depths to key beds, and of the axial hade of folds ; and it has been supplemented by the practice of drilling preliminary core holes (often on quite an intensive scale) to get a clue to the major features of the underground structure.

28. In Upper Assam the failure of the various test-wells was to a large extent conclusive discouragement, in the conditions then obtaining as regards technique of drilling and knowledge of prospecting possibilities, and effort towards the discovery of new oil resources was mainly concentrated in the direction which had the best hope of success—i.e. the extension of the Digboi oilfield. Here quite a striking series of successes have been obtained from time to time, interspersed with a corresponding set of disappointments, and the field was gradually extended to its present known limits, which are fairly sharply defined by structural factors in regard to depth and width across the structure, but which along the strike of the fold have been enormously extended (with resumption of production after intervening barren patches) according to the interplay between structure and the texture of the reservoir beds. This activity, although not included in the list of test wells in Appendix A, was essentially similar in nature and has continued up to the present day.

29. In the Surma Valley, during the corresponding period, it was felt that in spite of the failure of the earlier test wells there were still prospects if the difficulties involved could be overcome by sufficient thought and effort. Accordingly the most apparently promising of these areas—Masimpur, which is a structure of relatively large size—was selected for intensive effort, in the hope that the experience and success there gained could be applied to the other areas whose prospects were linked with it. For this reason there has been a continuous sequence of test wells in this same area (No. 7 is the next one planned) and a campaign of core-drilling involving more than 100 separate bore-holes (some over 5000 ft. deep) ; but although operations there have exhausted over 2 crores of rupees so far, and the last well reached 7685 ft, each difficulty surmounted has disclosed other problems ahead, and the area cannot yet be considered finally tested.

30. Independently of the connected sequence of operations recorded briefly above, an attempt was made by a different company from abroad to test the oil possibilities of this part of the world, which had previously been left mainly to the indigenous oil companies. A few wells were drilled in the Upper Assam belt, but they also had a similar lack of success.

31. The historical sequence of prospecting wells in the Indian Union (including their depths) is recorded in Appendix A and shown diagrammatically in Text-Fig.2. It shows how improvements in drilling technique have allowed wells to be carried deeper and deeper, thus extending the scope for testing.



Text Figure 2

DIAGRAM TO SHOW SEQUENCE OF THE MAIN PROSPECTING WELLS IN THE INDIAN UNION.

Each stroke represents an individual well according to date of starting and total depth reached.

32. During the recent war period, all prospecting effort had to be shut down at Government request in order to conserve material for work which was likely to yield immediate supplies of oil for the refinery, and it has only quite recently been possible to restore the supplies and organisation for resuming prospecting effort. At the present time the position changes from week to week, through a variety of factors ; apart from the test-wells for extending the Digboi field (which have shown a fairly definite termination of the field to the south-west, though there have been some recent quite striking successes in additions to the north-east), a test-well has been drilling at Tiru Hills in the Assam Valley and has (during the writing of this Address) proved one more example, unfortunately, of a prospect whose potentialities were cancelled out mainly by unpredictably unfavourable underground structure ; this was one of the few anticlinal structures still untested in the Assam Valley region. In the south-western part of the Tertiary belt, it has not yet been possible to make a final decision on programmes, but plans are in hand for drilling at Masimpur and (in Tripura) at Rokhia should circumstances allow.

33. A little before the war, it was decided that the technique of geophysical survey (which had been employed from time to time on local problems) was now sufficiently advanced to allow of a practical attempt to determine the prospects under the wide plains of alluvium. Surveys were started intensively over the whole sub-continent, then undivided ; the only portion appropriate for this work in the Indian Union was in the Upper Assam Valley, neglecting for the moment some portions at the western edge of the Indian Union, which will be referred to later.

34. The Assam Valley alluvium offers three main problems in this connection. Firstly, is there a sufficient thickness of sediments above the basement to give scope for prospects ; secondly, do anticlinal structures exist below the alluvium ; and thirdly, does the oil-bearing belt extend north of the Naga Thrust which runs along the edge of the exposed rocks? Of the data obtained on the first two points it would be premature to speak here ; the third point, on which Geophysics can give no answer (and only actual drilling can solve) might possibly prove to be of overwhelming importance, for so far no oilshows have been observed in rocks to the north of the Naga Thrust, and it is not impossible that they are different in facies from the oil-bearing rocks to the south.

FUTURE POSSIBILITIES

35. The prudent scientist who is anxious to preserve a reputation for soundness may be careful to confine his expressions of opinion to conclusions derived from demonstrable facts. The economic geologist, however, and particularly the oil geologist, spends much of his life in making forecasts about what will be discovered in the future, in the cheerful expectation of being proved wrong quite frequently ; it is, in fact, his continual professional duty to give opinions on insufficient evidence, and for him it is a far worse disgrace to fail to make some sort of forecast when requested than it would be to make an estimate and then be proved wrong, even though very large sums of money may be risked on the strength of his opinions. Following in these habits, I may perhaps be permitted to peer into the future and speculate about the further possibilities of oil resources in India, and the techniques that will be used to discover them.

36. For this purpose we may use a generalised Geological map (see Plate II) of the country. Firstly, we may exclude from discussion all that large part of the country which is composed of igneous or metamorphic rocks. That leaves us with three categories of sedimentary series ; the Tertiary beds, the pre-Tertiary rocks (e.g. Gondwanas etc.) and the oldest Palaeozoic and pre-Cambrian sediments.

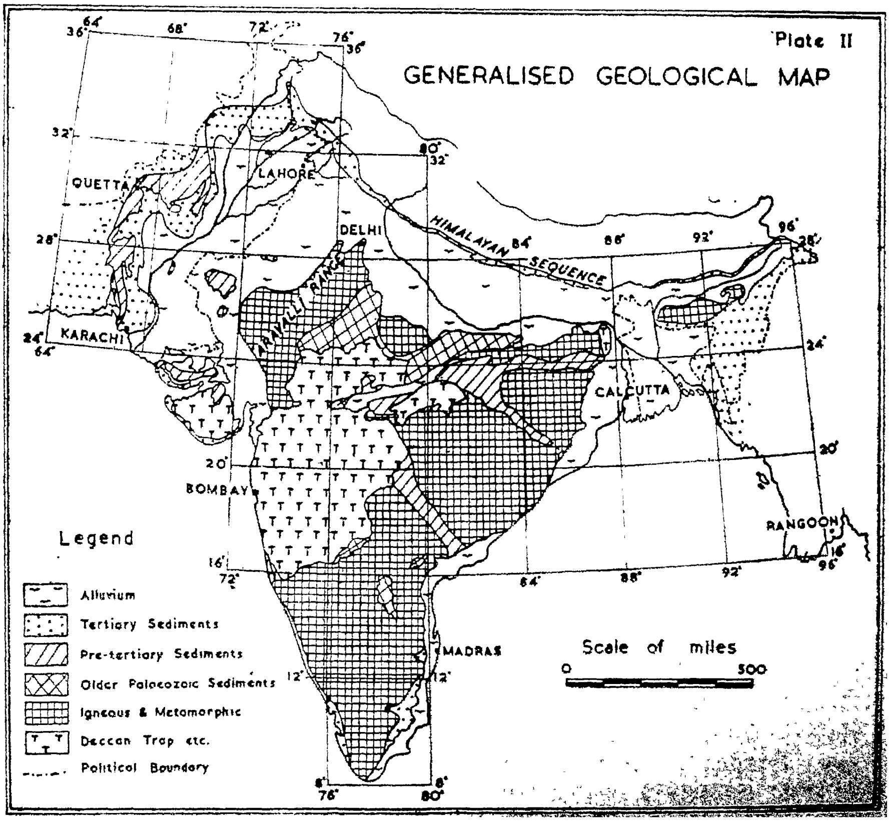


Plate II

GENERALISED GEOLOGICAL MAP

37. In the Tertiaries, we have already discussed the Assam oil belt and need not refer further. The remaining Tertiaries are presumably the next best group of potential oil rocks ; particularly the belt of Tertiaries running along under the Himalayas, of which the section nearest to the Punjab oil region would appear the most promising. The reasons for considering this region relatively unpromising for practical purposes are mainly : firstly, that it is intensively folded and faulted, so that the chances are small of finding a reasonably-sized structure sufficiently intact to hold oil ; and secondly, that although there are shows of gas in places there is no direct evidence of oil-forming conditions, and it may quite well be that there has been a regional development of gas without any liquid hydrocarbons.

38. There are a few other occurrences of Tertiary beds in the Indian Union, for example those fringing the Peninsular. Of these it may be said in general that, being narrow and minor developments bordering a mass that has remained relatively stable through long periods of geological time, they seem unlikely to have provided the type of environment which would give oil-forming conditions. There are Tertiaries again round Cutch, and Eocene rocks occur in patches through the alluvium of Jaisalmer ; but on the whole these beds seem to be too freely exposed, and to be too near the edge of their area of deposition to offer much promise.

39. Apart, however, from the Tertiary sediments in which all the known oilshows of India occur, we must allow for the fact that, speaking in quite general terms, sediments of any age at all, to the very oldest in which any forms of life existed, might have had a chance to develope oil-forming conditions and retain their oil if they have escaped later metamorphosis, or violent tectonic disturbance, or erosion.

40. It must be considered that the Gondwanas on the eastern side of the Peninsular were laid down in an environment suitable rather for coal formation; and, especially in the absence of any evidence of petroleum in any of the widespread localities where they have been examined, it seems most probable that they missed developing oil-forming conditions, at least in any developments still preserved from subsequent erosion.

41. On the Cutch and Jaisalmer side we have Jurassic sediments ; but these seem on the whole to be a shallow-water coastal facies, probably too well aerated for the preservation of potential oil-forming material. There are, of course, the well-known gas occurrences of Baroda—whether their origin is Recent or Tertiary or older—which have been found from time to time during shallow drilling (mainly for water, and not therefore discussed above) from 1911 onwards; but these have shown no signs of oil, and all the knowledge we have of the local structural and stratigraphic features seems to be against the expectation of any accumulations of oil of any significant size.

42. Then as regards such of the still older sediments as are unmetamorphosed, the main initial consideration is that for oil to be preserved to this day (if ever formed) over such a long period of time would require somewhat unusual conditions of freedom from tectonic disturbances combined with protection from erosion or near-surface exposure. So far there has not been any reason to explore such possibilities seriously, but on general grounds the prospects appear to be fairly remote.

43. Besides the regions discussed already, we have still to allow for the areas whose geology is hidden from us, by the Alluvium or by the Deccan Trap. The Upper Assam alluvial area was discussed earlier; but over the

remainder of the alluvial belt, as the geological map will show, the prospects are mainly those of the extension below the alluvium of pre-Tertiary rocks whose prospects seem poor or negligible. The least unfavourable region would seem to be to the west and north-west of Delhi; but the basement of igneous and metamorphosed rocks (such as appear at intervals as far away as Sarghoda near the Salt Range) must lie fairly near surface, without giving room for any thick development of sediments; and in principle the prospects must be presumed to be inferior to those across the border in Bahawalpur and West Punjab, where it is now known that the very extensive geophysical surveys have given discouraging results.

44. As regards the area beneath the Deccan Trap, we cannot say that it offers no potentialities, but looking for oil would be excessively speculative. There is no apparent reason why the Gondwanas (or any other sedimentary series) might not have an oil-bearing development somewhere in the trap-covered area: but we have no special reasons for expecting this to occur in any particular region, still less in any one closely defined locality. It would obviously present a very formidable (and perhaps insuperable) geophysical problem to deduce the structure and stratigraphy beneath the Trap, and when one considers that even if structure and stratigraphy could be revealed there would still not be any means of deducing the presence of oil (of whose existence in any such locality there is at present no evidence at all) then the whole prospect becomes so speculative as to be practically unattractive; the chances of failure are already sufficiently high even in prospecting apparently favourable areas.

45. Thus it seems unlikely that oil resources will be discovered in any useful quantity outside the eastern Tertiary belt which is still being examined. Except, however, in the case of the igneous and metamorphic area one cannot state categorically that oil prospects are entirely absent: but that is merely an example of the current limitations of certainty in these matters, complementary to the impossibility of promising definitely (in advance of drilling) that even the most favourably-indicated area will actually contain oil. The prospector can only list the prospects in an order of probability, and make his plans accordingly.

46. There is, of course, nothing scientifically abnormal in such a state of uncertainty regarding individual cases; the statisticians are quite accustomed to it, and a Life Assurance Company (for example) can make quite sound calculations based on group expectations, even though they remain uncertain about the extent to which any particular individual's life-span will correspond with normal expectations. In the case of oil prospecting, it will be realised, both the size of the statistical "population" and the knowledge of the relevant factors are so much smaller than for Life Assurance that prospecting remains an essentially speculative business.

47. It is worth considering whether any new development in technique might be expected to make a fundamental difference to the foregoing evaluation, and give a major increase in known resources. The one such innovation that seems at all possible is the invention of some means for making a direct determination from the surface of whether or not oil is physically present below the ground; even if it gave no indication about the size of the accumulation (a very important factor from the economic aspect) such a possibility would make a fundamental difference in our approach to the problem and would enormously widen the range of areas which it would be economically justifiable to test. But the fact remains that, in spite of occasional claims to the contrary, no such technique has yet been devised, and there is at present nothing to suggest that it may be forthcoming in any near future.

48. Failing a direct determination of oil in place, it would at least be a partial help if we could be certain of identifying oil source rocks when found; this would help in establishing the favourable prospects of a region. In spite of world-wide research in this matter, however, curiously little has been definitely established on this subject; and in practice it might not help us very much in deciding about test-wells in the Assam-Tripura belt.

49. There are a number of techniques which have recently been developed and applied particularly in regions where (as in some parts of the U.S.A.) practically all the possibilities of normal straight-forward surface inference have already been exhausted, and where there is still a high probability of obtaining oil if a suitably closed reservior remains concealed. Such techniques include studies on sedimentation and texture-analysis for the reconstruction of palaeogeography and the inference from them of the possible regional extent of oil-forming conditions and reservoir beds, including the possibilities of accumulations in stratigraphic traps.

50. Such studies (which in the U.S.A. are facilitated by a very large amount of regional underground evidence from oil borings) are not likely to be of major assistance in the Indian Union in the very near future: for we are still at the stage of exploring the possibilities of structures indicated by surface evidence (apart from anything that may be done in the alluvial areas), and only when some success in these provides the incentive to explore the more speculative possibilities of indirectly-indicated accumulations will these refined studies have any major application here. For the time being the eastern Tertiary belt offers a sufficiency of prospects of the more orthodox type for testing, and our first task is to make a determined effort to overcome the obstacles which have led eo such a relative lack of encouragement in past attempts. There seems every reason for sober hope that some measure of success will yet attend our efforts.

APPENDIX A

List of of Test Wells in the Indian Union

Year Started	District	Locality	Well		
			No.	Drilled by	Depth
1866	Upper Assam	Jaipur	1	McKillop Stewart & Co.	102
			2		171
			3		162
1867	,,	Makum	4	McKillop Stewart over & Co.	143
			5		82
			6		32
1888	,,	,,	1	Assam Railways & Trading Co.	110
			11		to 1241
1889	,,	Digboi	1	Assam Railway & Trading Co.	662
1891	,,	,,	2		720
			3		752
1892	,,	,,	4		910
1901	Surma Valley	Badarpur	1	W. G. Stoker	130
1909	,,	Khasimara	1	Preo Nath Sen	106
			2		192
1910	,,	Khasi	1	Mackenzie	25
1911	,,	Badarpur	2	Local Syndicate	730
1911	Gulf of Cambay	Gogha	1	Government	20
1912			2		430
1915			3		1016
	Surma Valley	Mahakhal	1	Assam Burma Petro Co.	(Shallow)
1913	,,	Badarpur	1	Budderpore Oil C.	677
1915	,,	,,	2	Burmah Oil Co.*	943
1915	Malabar Coast	Alleppey	1	Darrah Smail Co.	130
1918	,,	Narrakal	1	Cochin State	103
1918	Surma Valley	Masimpur	1	Burmah Oil Co.	1540
1918	Upper Assam	Makum	12	Assam Oil Co.	869
			13		685
			14		837
1920	Surma Valley	Masimpur	2	Burmah Oil Co.	3028
1920	Upper Assam	Balijan	1	Assam Oil Co.	719
1920	Surma Valley	Hilara	1	Burmah Oil Co.	2100
1920	Upper Assam	Namchik	1	Assam Oil Co.	592
			2		914
1921?	Gulf of Cambay	Jagatia	1-7	Baroda State	76-185
1921 1922	Gulf of Cambay	Baroda	1-7	State	147-622
1922	Surma Valley	Chhatachura	1	Burmah Oil Co.	2892
1922	,,	Kanchanpur	1	Burmah Oil Co.	2331
1922	,,	Masimpur	1	Burmah Oil Co.	3244
1923	Upper Assam	Barjan	1	Assam Oil Co.	1724
1923	,,	Namchik	3	Assam Oil Co.	837
1923	Surma Valley	Patharia	1	Burmah Oil Co.	2871
1925	Upper Assam	Baragolai	1	Assam Oil Co.	5545
1925	,,	Dhekiajuli	1	Assam Oil Co.	3925

1925	Surma Valley	Masimpur	4	Burmah Oil Co.	3293
1926	Gulf of Cambay	Baroda	6	State	179
1926	Upper Assam	Dilli	1	Assam Oil Co.	439
			2		329
1926	"	Ki Ker	1	Whitehall Petr. Corp.	2016
1926	"	Nichuguard	1	Whitehall Petr.	1000
			2	Corp.	1900
1927	Surma Valley	Patharia	2	Burmah Oil Co.	3436
1929	Gulf of Cambay	Baroda	7	State	231
			8		383
1930	Upper Assam	Bandersulia	1	Burmah Oil Co.	2757
1931	Surma Valley	Madimpur	5	Burmah Oil Co.	7685
1935	Gulf of Cambay	Gogna	1	Chinoy	960
1935	"	Hajat	1	Chinoy	
1949	Upper Assam	Tiru Hills	1	B.O.C. (I.C.) Ltd.	3500

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*Burmah Oil Co.—as the Burmah Oil Co. (India Concessions) Ltd. was then known.

NOTE. This list has been compiled from various sources, and is probably not exhaustive. It does not include the drilling at Digboi and Badarpur fields designed to extend their proved areas after initial confirmation, nor the large number of core-holes drilled only for structural and stratigraphical information without any expectation of oil possibilities.

APPENDIX B.

Selected Bibliography

1. *Capito, C. E.* "The oil-wells of Assam." Proc. Inst. C. Eng., Vol. CLXXXV, 363-378, (Abst. Journ. I.S.Inst. LXXXV, 477)—1911.

2. *Coates, J.* "The Construction of Geological Sections". Proc. 32nd Ind. Sci. Cong. (3) 56; and Q.J. Geol. Min & Met. Soc. Ind., Vol. XVII, (1), 1-11—1945.

3. *Corps, E. V.* "Digboi Oil Field, Assam". Bull. Amer. Assoc. Petr. Geol., Vol. 33 No. 1-1949.

4. *Evans, P.* "The Tertiary Succession in Assam". Trans. Min. & Geol. Inst. Ind. Vol. XXVII (3)—1932.

5. *Evans, P. and Crompton, W.* "Geological Factors in Gravity Interpretation Illustrated by Evidence from India and Burma". Q. J. Geol. Soc. Lond. Vol. CII, pp. 211-249—1946.

6. *Evans, P. and Emrick, B. R.* "Drilling and Fishing under Pressure at Masimpur, Assam". J.Inst. Petr.Techn., Vol. 22, 187-188—1936.

7. *Evans, P., Hayman, R. J., & Majeed, M.A.* "The Graphical Representation of Heavy Mineral Analyses". Proc. 20th Ind. Sci. Cong., 347; Proc. World Petroleum Congress London, Vol. 1, 251-256. (Also Q.J.Geol.Min&Met.Soc.Ind., Vol. VI(2), 27-34, 1934)—1933.

8. *Evans, P., and Majeed, M.A.* "The Heavy Minerals of the Assam Tertiaries". Proc. 25th Ind. Sci. Cong., (3) III—1938.

9. *Evans, P., and Vachell, E. T.* "Gravity Measurements in India". Proc. 29th Ind.Sci.Cong. (3) 123—1942.

10. *Evans, P., and Vachell, E. T.* "Some Gravity Problems of Eastern India". Proc. 29th Ind.Sci.Cong. (3) 123—1942.

11. *Hannay, P. S.* "On the Assam Petroleum Beds." Journ. A.S.B. XIV, 817-821 —1845.

12. *Hughes, T. W. H.* "Petroleum in Assam". Rec. G. S. I. VII, 55-58—1874.

13. *Rankine, A. O., and Evans, P.* "Geophysical Prospecting for Oil in India". Minerals Research Symposium. Nat.Inst. of Sc. of Ind. 1945.

14. *Pascoe, E. H.* "The Petroleum Occurrences of Assam and Bengal". Mem. G. S. I. Vol. XL (2)—1914.

15. *Wadia, D. N.* "Petroleum Resources of India". Special Publication No. XI of Ind.Assoc. for Cult. of Sc. Also in "Indian Minerals" Vol. I No. 4 and Vol. II

16. *Wilson, G. F.* "Drilling of a Deep Pressure Test in India". J.Inst.Petr.Techn. Vol. 23, 401-407—1937.

37th INDIAN SCIENCE CONGRESS, POONA, 1950

SECTION OF BOTANY

President: P. Maheswari, D.Sc., F.N.I.

Presidential Address

"CONTACTS BETWEEN EMBRYOLOGY, PHYSIOLOGY AND GENETICS"

In addressing you today I must first remind you of those members of the Botany Section who have passed away since we met last. Prof. Birbal Sahni F.R.S., who presided over this section in the years 1921 and 1938, and over the Geology section in the year 1925, and was also the General President of the Indian Science Congress Association in 1940, had been the leading botanist of our country for nearly three decades. He and his pupils contributed many papers to these meetings and his presence always illumined our proceedings. Prof. J.F.R. D'Almeida, who was Recorder for this session, was an authority on ferns and carried out important taxonomic work on the flora of the Bombay Presidency.

Ladies and gentlemen, I would request you to stand for a couple of minutes to honour the memory of these men.

As I looked over the addresses of the previous presidents of this section, I found that they had dealt with an extremely varied assemblage of subjects covering almost all branches of botany. I find only one noteworthy exception —the science of Plant Embryology. My election to the Presidentship was probably to fill this gap. I would request you to bear with me in my humble attempt towards this end.

There is an impression in the minds of some people that embryology is a purely descriptive study of embryo sacs and embryos. Five years ago (Maheshwari, 1945), in an address read before the Indian Botanical Society, I attempted to indicate the importance of embryological studies in the solution of phylogenetic problems. Today I wish to discuss the vast openings for research which exist in the field of Experimental Embryology and the contacts which this has with Physiology, Genetics and Plant Breeding.

The Barriers to Crossability in Plants

Ever since the rediscovery of Mendel's laws in 1900, breeders have been increasingly active in crossing different varieties, species and genera with a view to producing newer and more useful types. But since the germ cells of angiosperms are not free-swimming structures, there are many processes which have to be undergone before gametic fusion can take place. Indeed, as Focke (1881) said in his well-known book entitled "Die Pflanzenmischlinge," only a carefully planned series of experiments can show whether two plants will hybridize or not.

What are the breeder's difficulties in his attempt to cross two plants? There may be a disharmony in the time of flowering of the two parents, or flowering may be too infrequent. One of the plants may be a native of one country and another of a different country thousands of miles away. The pollen may refuse to germinate on the stigma. The pollen tubes may burst or die in the style or grow too slowly to reach the ovules in time. The generative cell may fail to divide; and even if it divides the sperm may fail to fertilize the egg. Or, syngamy takes place but the polar nuclei are not fertilized resulting in lack of endosperm. Finally although fertilization takes place normally, the development of the embryo may be arrested at an early stage so that no viable seeds are produced.

INFREQUENT FLOWERING OR DISHARMONY IN TIME OF FLOWERING OF THE PARENTS

When there is only a slight disparity in the flowering season of the two parents, it is usually possible to overcome the difficulty by making small adjustments in the time of sowing or by retaining the crop in off season. In cold countries the late flowering plants are often transferred to a hothouse to hasten their blooming. Or, early sowing may be resorted to. In dealing with an early flowering variety, the reverse measures may naturally be used with advantage.

When the disparity is of a higher order or flowering is infrequent, special methods must be used. In many cases the vegetative phase can be broken or shortened and the reproductive phase initiated by altering the environmental conditions. Changes in photoperiod, temperature, and nutrition are some of the devices which may be used for this purpose.[1]

Recently, chemical treatments have been used with the same object. Zimmerman and Hitchcock (1942, 1949) report that under the influence of tri-iodobenzoic acid, applied to the soil or sprayed on to the plants themselves, axillary buds of tomato which normally produce leafy shoots can be induced to grow flower clusters. The main stem of the plant also loses the shoot producing bud and terminates in an inflorescence. Very spectacular results have been obtained by Van Overbeek (1946) on pineapples. Normally pineapples of the Calezona variety flower in Hawai in December, but applications of 0.25-0.50 mg. of naphthalene acetic acid could induce flowering at any time of the year. The treatment is simple. A few drops of the solution are applied to the centre of the crown. Flowers appear in about 7 weeks after treatment and the fruits are ready for harvesting approximately 13 weeks later.

The work done by several other authors (Thimann and Lane, 1938; Stier and du Buy, 1938; Green and Fuller, 1948; Leopold and Thimann, 1949) seems to confirm that while large doses of auxins inhibit or delay flowering, very weak concentrations of the same promote it. This is a very fruitful field of research which will no doubt be turned to great economic advantage in future years.

STORAGE OF POLLEN[2]

When the two parents are widely separated from each other both in time (of flowering) and space, a very useful device is to store the pollen and transport it from one place to another. Date pollen is said to retain its viability for a whole year and used to be an important article of commerce

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1. For further information see Gregory (1948) and Hamner (1948).
2. For a more detailed treatment of this topic see Maheshwari (1944).

in the past . Most pollens, however, remain viable only for a few days or weeks and the range of variation in this respect may be illustrated by a few examples from common plants. In *Hordeum* (Anthony and Harlan, 1920) and *Oryza* (Nagao and Takano, 1938) fertilization cannot be secured with certainty unless the pollen is transferred directly from the anther to the stigma. In *Sorghum* (Stephens and Quinby, 1934) no seed could be obtained when pollen was used five hours or more after collection. In some experiments at Coimbatore 65 per cent of the pollen grains of *Gossypium* were found to retain their viability up to the 24th hour but none after twice this period (Banerji, 1929). At New Delhi the pollen of *Solanum melongena* remains viable for only one day in summer and two to three days in winter (Pal and Singh, 1943).

Recent work has shown that whatever the viability might be under natural conditions, it can almost always be prolonged to an appreciable extent by storing the pollen under proper conditions. Holman and Brubaker (1926), who have reviewed the older literature, mention the extension of longevity of *Cyclamen* pollen from 18 to 185 days and that of *Listera ovata* from 40 to 164 days. Samples of *Typha* pollen, which had been stored in a calcium chloride desiccator for 71, 94, 116 and 158 days, gave respectively 75, 70, 65 and 56 per cent germination, and 2 per cent of the pollen grains remained viable even after 336 days. Air dry pollen of *Coffea* stored in the ordinary way loses its germination power within a week but when kept in a desiccator it retains the same for over a month (Ferwerda, 1937). Pfeiffer (1944), who made similar experiments with *Cinchona,* found that 5 to 19 per cent of the pollen retained its viability even after a year's storage in darkness at a temperature of 10°C. and a humidity of 35 to 50 per cent. Nebel (1939) has been able to preserve apple pollen for four and a half years and sour cherry pollen for five and a half years at a temperature of 2—8°C. and a humidity of 50 per cent. Even grass pollen, which is notoriously ephemeral, has been kept alive for 15 to 30 times the period of its natural viability. To mention only two examples, the pollen of *Saccharum spontaneum* (a wild cane used in crosses with the cultivated canes) spread out on a watch glass in diffused light remained viable for only about six hours; that stored in vials plugged with cotton and kept at room temperature for 12 to 24 hours; and the same kept at 7°C. for more than a week (Sartorius, 1942). Similarly, the pollen of *Zea mays* stored in pollinating bags in direct sunlight at a maximum temperature of 46°C. remained viable for only three hours; that stored in shade at a maximum temperature of 30°C. for 30 hours; and the same kept in tassel at a temperature of 4.5°C. and a relative humidity of 90 per cent for eight to nine days (Jones and Newell, 1948).

The data given above indicate that the most important factor in pollen storage is temperature and the next is relative humidity. Strong light is harmful and diffused light or even complete darkness seem to be more conducive to successful storage.

RECEPTIVITY OF THE STIGMA

Equal in importance to the viability of pollen is the receptivity of the stigma, but this is less amenable to control. In most plants the stigma is

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3. Stout (1924) contradicts this and says that he found no evidence of survival of air dry date pollen for more than 77 days, but as pointed out by Holman and Brubaker (1926) it is possible that under favourable conditions the period may be much longer.

receptive for only a short period and if the pollen is not transferred to it at the right time, it fails to germinate or the germination is so slow that the flower withers and falls off before the pollen tubes can reach the ovules. Attempts to prolong the receptivity of the stigma have usually been unsuccessful; or, they are associated with secondary effects which make it difficult to derive much benefit from such prolongation. For instance, although a lowering of the temperature can lengthen the blooming period and also extend the period of receptivity of the stigma to a certain extent, it has an adverse effect on the rate of growth of the pollen tube so that the net gain is practically nil.

MECHANICAL DEVICES FOR BRINGING THE POLLEN GRAINS OR POLLEN TUBES IN PROXIMITY TO OVULES

In most cases the difficulty is not so much in the initial germination of the pollen as in the subsequent growth of the pollen tubes in a foreign style. This may be due to two reasons: (*a*) the maximum length attainable by the pollen tubes of the male parent is inadequate for enabling them to reach the ovules, and|or (*b*) the unfavourable medium through which they have to make their way causes an excessive retardation of their growth. Two examples may be cited. When the long-styled flowers of *Datura* are pollinated with pollen from short-styled flowers, many of the pollen tubes burst and fertilization is rendered improbable (Buchholz *et al*, 1935). When the self-sterile *Brugmansias* (Joshi, 1948) are self-pollinated, the pollen grains germinate freely but only a few pollen tubes grow beyond the stigmatic region. The maximum distance traversed by them during the several days before the flowers drop off does not exceed more than one fourth the length of the style. In cross-pollinations, on the other hand, the pollen tubes grow normally and viable seeds are produced.

When failure of a cross is due to such causes, one obvious remedy is to amputate the style and reduce it to suitable length. In a cross between *Zea* and *Tripsacum* Manglesdorf and Reeves (1931) shortened the style of the former to a length suitable for the pollen tube of *Tripsacum* and thereby obtained intergeneric hybrids. However, since the cut end of the style is not always so suitable for pollen germination as the stigma, sometimes it is desirable to use a different method in which the middle portion of the style is removed and the upper and lower portions are then joined together and held in place (Buchholz, Doak and Blakeslee, 1932). [4]

A Japanese worker, Yasuda (1931), has gone one step further and attempted an actual graft of the style upon the [3] ovary in *Petunia violacea* He cut off the style of one flower and glued it with gelatin to the ovary of another whose style had been previously cut away. In order to prevent the falling apart of the grafted style, he supported it against an iron wire tying the support and the style with a spider's thread. When the operation was successful, the grafted style grew normally and attained its usual size. On the other hand, if the tissues failed to unite, the style turned brown and soon withered away.

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4. Sanz (1945) introduced pollen inside vertical slits cut in the tops of decapitated styles of *Datura*.

5. In this species there are several self-sterile races. Pollen tubes from own pollen grains are too slow in their growth, but those from pollen grains of other races grow normally and effect fertilization.

Yasuda's method requires a great deal of manipulative skill and has apparently never been tried by any other worker. Although it seems to be impracticable with plants having thin styles, it can perhaps be used with profit when the styles are reasonably thick. A grafting of the style of the species used as the paternal parent to the ovary of the maternal parent is certainly a promising method of combating the incompatibility between two species or varieties.

A further improvement would be to devise some method of introducing the pollen grains directly into the ovary.[6] Somewhat reminiscent of the artificial insemination practised in animals, this technique has not so far been perfected for plants. That it is entirely possible to do so, however, is indicated by some experiments of Dahlgren (1926) who succeeded in bringing about fertilization of the ovules of *Codonopsis ovata* by this method. More recently, Bosio (1940) tried some "intraovarial pollinations" in *Helleborus* and *Paeonia.* He emasculated the flowers and either removed the stigmas or painted them with celloidin. Then an incision was made in the ovary and the pollen grains introduced into it artificially. In *Helleborus* the germination was inadequate to cause any fertilization but in *Paeonia* several ovules were fertilized yielding viable seeds. In explanation of this difference in the behaviour of the two genera, the author says that the pollen of the Ranunculaceae requires for its germination a sugary medium with a pH close to neutral. Within the ovary of *Helleborus* there is no free liquid and the pH of the cells lining it is about 4; in *Paeonia,* on the other hand, the cells at the base of the ovarian cavity secrete an abundant liquid which has a suitable concentration of sugar and a pH of about 6. Germination of the pollen, therefore, fails in the former but is quite successful in the latter. In nature it occurs in both cases, since the stigma fulfills the required conditions.

CHEMICAL STIMULATION OF POLLEN TUBE GROWTH

Breeders sometimes use "bud pollination" to achieve a difficult cross. The increased fertility obtained by this method has been attributed to two factors. One is that it gives more time to the pollen tubes to reach the ovules. The second is that possibly the mature style and stigma secrete certain substances which inhibit the growth of the pollen tubes; by bud pollination the breeder circumvents this trouble and catches the stigma at a time when the secretion has not yet begun to take place.

However, bud pollination is not always successful. Pollen frequently fails to germinate on an immature or unreceptive stigma, and a better method would be to encourage the growth of the pollen tubes by the application of suitable chemicals either to the pollen grains or to the stigmas. P. F. Smith (1942) has shown that in artificial cultures 3-indoleacetic acid, in concentrations of one in a million, appreciably stimulates the germination of the pollen as well as the rate of elongation of the pollen tubes. Addicott (1943) has reported that several substances including vitamins, plant hormones, pyridines and puriness produce similar effects. Löve and Löve (1945) state that animal sex hormones, both male and female, have a stimulating effect on the growth of pollen tubes. In pollen tube cultures of *Rumex tenuifolius,* treated with oestron and ostradiol, this effect was found to be especially pronounced as the length of the tubes was 63 and 71 per cent greater than in the controls.

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[6] Intraovarial pollen grains have been reported in nature in *Butomopsis* (Johri, 1936), *Erythronium* (Haque, 1949), and *Trillium* (Johri and Eunus, 1950), but it is not certain if they germinate inside the ovary and cause fertilization.

More recently Huang (1948) has found that in *Prunus armeniaca, P. persica* and *Pinus massoniana* the addition of micro-elements (except CuSO4) to the culture medium is markedly favourable for pollen germination and pollen tube growth, and that vitamins, some amino acids and other organic acids also moderately stimulate both germination and tube elongation.[7]

What has been found true of artificial cultures is also applicable to plants in the field. Eyster (1941) has reported that the self-incompatibility in *Petunia, Tagetes, Trifolium repens* and *Brassica oleracea* can be counteracted by spraying α-napthalene acetamide immediately before or shortly after pollination. This chemical is said to "neutralize the effects of an ovarian secretion which diffuses into the style and inhibits or greatly retards the growth of pollen tubes." Emsweller and Stuart (1948) have confirmed this in the case of *Lilium longiflorum,* a species composed of self-incompatible clonal groups which fail to set seed on self-pollination. The application of 1 per cent naphthalene acetamide was found to be of great advantage not only in overcoming self-incompatibility but also in facilitating some intra and interspecific crosses which were otherwise very difficult.[8]

INCOMPATIBILITY IN RELATION TO CHROMOSOME NUMBER OF THE TWO PARENTS

Sometimes a change in the chromosome number of one of the parents has a remarkable effect in the inactivation of incompatibilities. As the result of a series of controlled pollinations, Stout and Chandler (1941) and Stout (1944) showed that the potentially fertile flowers of *Petunia axillaris* are wholly self-incompatible and produce no seeds or capsules on self-pollination. However, the self-pollinated flowers of tetraploid branches (produced by colchicine treatment) produced large well-filled capsules. Flowers on the self-incompatible diploid branches also produced capsules when pollinated from flowers of tetraploid branches on the same plant, but tetraploid x diploid combinations on the same plant failed to yield any seeds.

Of interest in this connection are also some observations of Buchholz and Blakeslee (1929), Satina (1944), and Blakeslee (1945) on *Datura.* When pollen from a *2n* plant is applied to the stigma of a *4n* plant, fertilization takes place freely and some viable seeds are also produced; but in the reciprocal cross when pollen is applied from a *4n* plant to a *2n* stigma, seed formation is extremely rare. Histological studies have shown that the pollen tubes derived from the *4n* male parent burst in the *2n* styles and never reach the ovary (see also Handler, 1948). It was possible, however, to overcome this difficulty and change the *2n* x *4n* cross from an incompatible to a compatible one in an ingenious way. Treatment with colchicine usually results in periclinal chimaeras in *Datura.* Some of these have the doubled chromosome number in the epidermal layer but not in the underlying tissues. Since it is the epidermal layer which forms the transmitting tissue in the style of *Datura,* a periclinal chimaera with a a *4n* epidermis should react exactly like a pure *4n* parent so far as its relation to pollen tubes from a *4n* male parent is concerned. This was actually found to be the case and diploid pollen tubes from *4n* males grew readily without bursting in styles of a periclinal chimaera with a *4n* epidermis. From his work on *Nicotiana,* Kostoff (1934) also concludes that "pollen-tubes, originating from species that have larger chromosome number, grow slower in the styles of species having smaller chromosome number, than those originating from species with smaller chromosome number, when grown in styles of species with larger chromosome number, Consequently, a species cross A x B would be more successful than its reciprocal B x A, when A has a larger chromosome number than B, because the pollen-tubes of B reach easier the ovary of A than in the reverse cross."[9]

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[7] See Vasilyev (1937) on the importance of boron in the growth of pollen tubes apple and pear; he suggests its use in spray form on the trees in order to obtain a her fruit set. Svolba (1942) stresses the importance of pH value.

[8] Lewis (1942) reports that in incompatible pollinations in cherry (*Prunus avium*) e application of α-napthalene acetamide, either in aqueous solutions or in lanolin nears, had no effect on the rate of pollen tube growth, but it delayed the formation f an abscission layer at the base of the style thereby allowing a longer time to the ncompatible tubes to reach the ovary.

Failure of Fusion of the Male and Female Nuclei

Finally, there remains the difficulty that even after the pollen tubes have reached the ovary and ovules, fertilization may fail to occur for some obscure reason. A couple of examples may be mentioned. When the flowers of *Ribes nigrum* are selfed, the pollen tubes enter the ovules and "even lay themselves against the embryo-sac nucleus" but the male and female nuclei do not fuse and hence no seeds are formed (Ledeboar and Rietsema, 1940). In plants of *Oxalis cernua* (Krupko, 1944) growing in the Mediterranean region, the pollen tube enters the embryo sac and discharges its nuclei, but fertilization fails to occur.[10]

Since there is no known method of overcoming this trouble, it is not necessary to discuss the point further.

Embryo Culture

In the preceding pages we have considered the possibilities of overcoming some of the barriers to fertilization. It has frequently been observed, however, that even after gametic fusion has taken place something may arrest the growth of the embryo so that the resulting seeds are non-viable. To mention a few examples, in the cross *Datura stramonium* X *D. metel* (Satina and Blakeslee, 1935), the hybrid embryo degenerates after undergoing only two or three divisions. In the cross *D. pruinosa* X *D. metel* the primary endosperm nucleus undergoes several divisions but the zyote usually remains undivided. In two other crosses, *D. meteloides* X *D. discolor* and *D. ceratocaula* X *D. meteloides* (Sachet, 1948), most of the ovules are fertilized and the endosperm and embryo at first develop normally, though rather slowly. After the embryo has reached the spherical stage, the endosperm starts disintegrating accompanied by the enlargement and active division of the cells of the integumentary tapetum or endothelium lying just outside it. This layer forms a voluminous mass which invades the cavity of the embryo sac and replaces the endosperm. The embryo survives in this mass for a few days but does not undergo further divisions. Ultimately it degenerates and disappears and no viable seeds are produced.

Recent research has shown that in such cases it is frequently possible to excise the young embryos from the ovules and grow them in artificial media—a process not unlike the well-known Caesarean operation in which an immature animal embryo is removed from the body of the mother and grown in an incubator.

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[9] See also Fagerlind (1944) who concludes that generally there is a greater compatibility when the chromosome number of the maternal parent exceeds that of the paternal.

[10] Apogamic embryos are, however, formed quite frequently in the micropylar part of the embryo sac.

In tracing the development of this new technique of embryo culture we find that Hannig (1904) was the first to have made a successful attempt of this kind. Using certain crucifers (*e.g., Raphanus* and *Cochlearia*) as the objects of his study, he tested a variety of nutrient media containing sugars, mineral salts, plant decoctions, certain amino acids and gelatin. Mature plants were reared from embryos only 1.2 mm. in length at the time of excision, although presumabaly the radicle, plumule and cotyledons had already been formed at this stage. Stingl (1907) grew embryos of several cereals, but instead of placing them in culture media he transferred them to the endosperms of other genera of the family.[11] Dietrich (1924), who experimented some years later with a larger variety of plants than any of his predecessors, found that Knop's solution with 2.5 to 5 per cent cane sugar and 1.5 per cent agar enabled prompt growth of immature embryos of several species. He further observed that the cultured embryos tended to skip the stages of development which had not been completed at the time of excision and grew directly into seedlings. However, his efforts to cultivate very young embryos, less than one-third of their mature size, were unsuccessful.

The work of Hannig, Stingl and Dietrich, although of great importance, seems to have been prompted more by curiosity than any other reason, and the possibility of using the method to economic advantage was first pointed out by Laibach (1925, 1929). While making some interspecific crosses in the genus *Linum,* he found that the cross *L. perenne* x *L. austriacum* yielded fruits of approximately normal size but the seeds were greatly shrunken and only about half as heavy as the normal seeds. By dissecting out the embryos and placing them upon damp blotting paper he was able to induce their germination and the resulting plants flowered and fruited abundantly. The reciprocal cross *L. austriacum* x *L. perenne* was more difficult, for here the fruits shed prematurely when the seeds had only one-thirteenth of the weight of normal seeds and were incapable of germination. However, by excising the embryos when they were about a fortnight old and placing them in little tubes on cotton wadding containing 10-15 per cent cane sugar, he was able to promote their growth. A couple of weeks later they were removed from the sugar solution and placed on moist blotting paper, where they germinated within a few days and eventually yielded vigorous plants which flowered and fruited normally. Laibach, therefore, expressed the opinion that a similar method of "artificial premature birth" could perhaps be used to obtain offspring from various other crosses which had so far proved unfruitful. In conclusion he said: "In any case, I deem it advisable to be cautious in declaring combinations between higher plants to be unviable after fertilization has taken place and after they have begun to develop. Experiments to bring the aborted seed to development should always be undertaken, if it is desirable for theoretical or practical reasons. The experiments will not always be successful, but many a result might be obtained by studying the conditions of ripeness of the embryos and by finding out the right time for the preparing out of the seeds."

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[11] Recently Camara (1943) has performed a number of similar transplantation experiments with cereals. It is interesting to note that embryos of *Triticum vulgare* grew better on endosperm of *Secale* than on that of *T. durum* or *T. turgidum.*

Laibach's brilliant exposition gave the lead for more intensive work on the artificial culturing of embryos and during recent years a number of papers have appeared on the subject. In several crosses, which were formerly unsuccessful, the hybrid embryos have now been reared to maturity.

In mentioning some specific cases where this technique has been used with success, we may first refer to certain stone fruits, such as *Prūnus avium* (sweet cherry), *P. domestica* (plum) and *P. persica* (peach). When early ripening varieties of these plants are used as female parents, the embryos abort and the seeds are not viable. Tukey (1944) made artificial cultures of the embryos and grew mature plants from them. The procedure adopted was to split the stony endocarp with a scalpel, cut carefully through the integuments, nucellus and endosperm, and drop the embryos under aseptic conditions into bottles containing nutrient agar. The seedlings arising from them were first transplanted to sterile sand watered with a nutrient solution and then to soil. In time, they developed into vigorous fruiting trees.

To mention a few other examples Jϕrgensen (1928) used the embryo culture method to obtain hybrids between *Solanum nigrum* and *S. luteum* ; Bensley (1930) between *Gossypium hirsutum* and *G. herbaceum* ; Skirm (1942) between some species of *Prunus* and of *Lilium* ; Brink, Cooper and Ausherman (1944) between *Hordeum jubatum* and *Secale cereale* ; Smith (1944) between *Lycopersicon esculentum* and *L. peruvianum* ; Iwanowskaya (1946) between *Triticum durum* and *Elymus arenarius* ; and Sanders (1948) between several species of *Datura*.

Since conditions favorable for the growth of the embryos are also favorable for the growth of various bacteria and fungi, proper precautions have of course to be taken both at the time of dissection of the embryos and during their transfer to the culture medium to save the cultures from contamination.

A most important factor is the composition of the medium. Older embryos are largely autotrophic and usually present little difficulty. The present problem, however, is to try to rear embryos in younger stages of development. Frequently the minute embryo dies in culture or growth results in the formation of callus like tissue only.

While it must be therefore be admitted that there are difficulties in embryo culture which still need to be conquered, there is no doubt that the concentrated attack which is being made on the problem under the leadership of Blakeslee, La Rue, Brink, and others will help to overcome them. Embryo culture has proved to be of great economic value not only in the achievement of a much wider range of hybrid combinations than was possible up to this time, but also in the quick germination of seeds which normally require a dormant period of months and years so that the breeder is saved the uncertainty and delay which troubled him previously. [12]

INDUCED PARTHENOGENESIS

Finally, we come to the problem of inducing the development of embryos from unfertilized eggs. In normal fertilization the sperm imparts not only the activating stimulus but also a set of genes embodying the contribution of the male parent towards the make-up of the new individual. The prime interest in induced parthenogenesis lies in the fact that if the stimulus can be provided without the usually accompanying paternal genes; it would greatly facilitate the task of the geneticist in producing a homozygous true-breeding type which otherwise requires a long and laborious process of self-fertilization (East, 1930).

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[12] Since excised embryos skip this period of dormancy, the embryo culture method can also be used to make tests of the germinating capacity of seeds. The non-viable embryos become discolored and soon deteriorate while the viable embryos show various degrees of hypocotyl development and cotyledon enlargenment and become green in colour (see Barton and Crocker, 1948).

Ever since the initial discovery of a *Datura* haploid (Blakeslee *et al*, 1922), a variety of physical and chemical treatments have been tried to produce haploids artificially. The chief of these are: (*a*) exposure of flowering shoots to very high or very low temperatures or to x-rays (*b*) use of x-rayed or of foreign pollen on stigma; (*c*) delayed pollination; and (*d*) chemical treatment.

To give an exhaustive survey of the successes and failures that have attended these efforts is beyond the scope of this address and will not be attempted. A few examples are mentioned, however, to indicate the nature of work that has been done.[13]

Concerning the effect of temperature, it is interesting to not that Müntzing (1937) obtained a haploid plant of *Secale cereale* by exposing the spikes to low temperatures (0.3°C), while Nordenskiod (1939) did the same by exposing them to high temperatures (41°-42C)[14].

Kihara and Katayama (1932) obtained three haploids of *Triticum monococcum* from spikes which had been exposed to X-rays at the time of meiosis. Later, Katayama (1934, 1935) pollinated the stigmas with X-rayed pollen and out of 91 seedlings raised by him 16 turned out to be haploids. However, most other workers have been far less successful, and Smith (1946) categorically states that he failed to obtain any increase in the number of haploids by X-ray treatment.

The use of foreign pollen for inducing haploidy was first brought into prominence by Jφrgensen (1928) work on *Solanum nigrum*. Following interspecific or intergeneric crossings, the formation of haploid embryos has also been reported in *Brassica* (Nogouchi, 1928), *Oenothera* (Gates and Goodwin, 1930), *Triticum* (Nakajima, 1935) and a few other plants.

Kihara (1940) found that in *Triticum monococcum* the frequency of haploids could also be augmented by merely delaying the time of pollination. By applying pollen on the sixth day after emasculation he obtained two haploids among 10 plants, on the seventh day four haploids among 44 plants, on the eighth day five haploids among 18 plants, and on the ninth day three haploids among 8 plants.

Yasuda (1940) injected aqueous solutions of "belvitan" in the ovaries of *Petunia violacea*. In ovules fixed and sectioned three days after treatment he observed some striking changes. In some cases the nucellar cells[15] were found to have enlarged as the result of such stimulation; in others the egg had divided once or twice forming a small proembryo; and in still others the antipodal cells had increased in volume. In explanation of the fact that division occurred only in the egg and the other cells merely enlarged, the author says that belvitan promotes cell-division, in embryonic cells while in mature cells it causes only a growth of the cell-wall.

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[13] For further information see reviews by Ivanov (1938) and Kostoff (1942).

[14] By similar treatment in mammals seven parthenogenetic rabbits have been produced, six by treatment of the eggs with heat hypertonicity *in vitro* and subsequent implanation in a prepared doe (Pincus, 1939 a, b), and one by cooling exposed fallopian tubes containing eggs (Pincus and Shapiro, 1940).

[15] These must really be the cells of the integumentary tapetum, for the nucellus disorganizes at an early stage in all members of the Solanaceae.

Yasuda's observations, although interesting, are still in a preliminary stage, for it is not clear whether the embryos he obtained were haploid or diploid nor does he mention if he succeeded in following them to later stages of development.

It must therefore be confessed that so far we have not succeeded in finding a suitable method for inducing parthenogenesis in higher plants. Although exposure to temperature extremes and other shocks and pollination with X-rayed or foreign pollen have apparently given some positive results in special cases, the number of parthenogenetic plants obtained by these methods is too small to warrant the deduction of a definite causal relationship between the treatment and results. What is really needed is an agent for producing haploid plants which will give positive results with approximately the same consistency as colchicine does in producing polyploidy. A logical method of approaching the problem would be to know what are the changes that take place inside the embryo sac in known cases of haploid parthenogenesis and then attempt to duplicate them artificially. From the very meagre information that we possess in this regard it seems that although the egg can frequently be made to develop parthenogenetically, the real difficulty lies in an initiation of endosperm formation. It is for future research to suggest ways and means of overcoming this difficulty.

CONCLUSION

Ladies and gentlemen, the subject of my address has been rather wide. In the short time at my disposal I have only been able to touch upon some aspects of it, and those not in any way comprehensively. I hope, however, that what I have said will serve to indicate that the inactivation of incompatibilities, the artificial culture of immature embryos, and the production of haploid embryos from unfertilised eggs are problems of outstanding importance in applied and economic botany. Their solution requires the joint efforts of embryologists, cytologists, geneticists and physiologists. We need several teams of researchers in the Universities and in the Agricultural Institutes of our country to take up the work. I hope that it will receive the encouragement that it deserves.

LITERATURE CITED

ADDICOTT, F. T. 1942. Pollen germination and pollen tube growth as influenced by pure growth substances. Plant Physiol. *18*: 270-279.

ANTHONY, S. and HARLAN, H. V. 1920. Germination of barley pollen. Jour. Agri. Res. *18*: 525-536.

BANERJEE, I. 1929. Studies in cotton pollen. Agri. Jour. India *24*: 332-340.

BARTON, L. V. and CROCKER, W. 1948. *"Twenty years of seed research at Boyce Thompson Institute for plant research."* London.

BENSLEY, J. C. 1940. Hybridization of American 26-chromosome and Asiatic 13-chromosome species of *Gossypium*. Jour. Agri. Res. *60*: 175-182.

BLAKESLEE, A. F. 1945. Removing some barriers to crossability in plants. Proc. Amer. Phil. Soc. *89*: 561-574.

————BELLING, J., FARNHAM, M. E., and BERGNER, A. D. 1922. A haploid mutant in the Jimson weed, *Datura stramonium*. Science *55*: 646-657.

————and SATINA, S. 1944. New hybrids from incompatible crosses in *Datura* through culture of excised embryos on malt media. Science *99*: 331-334.

BOSIO, M. G. 1940. Ricerche sulla fecondazione intraovarica in *Helleborus* e *Paeonia*. Nuovo Giorn. Bot. Ital. N.S. *47*: 591-598.

BRINK, R. A., COOPER, D. C., and AUSHERMAN, L. E. 1944. A hybrid between *Hordeum jubatum* and *Secale cereale* reared from an artificially cultivated embryo. Jour. Hered. *35*: 67-75.

BUCHHOLZ, J. T. and BLAKESLEE, A. F. 1929. Pollen-tube growth in crosses between balanced chromosomal types of *Datura stramonium*. Genetics *14*: 538-568.

————DOAK, C. C. and BLAKESLEE, A. F. 1932. Control of gametophytic selection in *Datura* through shortening and splicing of styles. Bull Torrey Bot. Club 59: 109-118.

————WILLIAMS, L. F. and BLAKESLEE, A. F. 1935. Pollen tube growth of ten species of *Datura* in interspecific pollinations. Proc. Nat. Acad. Sci. U.S.A. *21*: 651-656.

CAMARA, A. 1943. Transplantacao de embrioes. Agron. Lusitana *5*: 375-386.

DAHLGREN, K. V. O. 1926. Svensk Bot. Tidskr. *20*: 97.

DIETRICH, K. 1924. Über Kultur von Embryonen ausserhalb das Samens. Flora *17*: 379-417.

EAST, E. M. 1930. The production of homozygotes through reduced parthenogenesis. Science *72*: 148-149.

EMSWELLER, S. L. and STUART, N. W. 1948. Use of growth regulating substances to overcome incompatibilities in *Lilium*. Proc. Amer. Hort. Sci. *51*: 581-589.

EYSTER, H. C. 1941. Pollen tube gowth of a self-sterile strain of *Petunia*. Proc. South Dacota Acad. Sci. *21*: 56-57.

FAGERLIND, F. 1944. Kompatibilität und Inkompatibilität in der Gattung *Rosa*. Acta Horti Bergiani *13*: 247-302.

FERWERDA, F. P. 1937. Keimkracht en levensduur van koffiestuifmeel, Arch. Koffiecult. Ned.—Ind. *11*: 135-150.

FOCKE, W. O. *"Die Pflanzenmischlinge."* Berlin.

GATES, R. R. and GOODWIN, K. M. 1930. A new haploid *Oenothera*, with some observations on haploidy in plants and animals. Jour. Genetics *23*: 123-156.

GREEN, M. and FULLER, H. J. 1948. Indole-3-acetic acid and flowering. Science *108*: 415-416.

GREGORY, F. G. 1948. The control of flowering in plants. Symposia Soc. Expt. Biol. *2*: 75-103.

HAMNER, K. C. 1948. Factors governing the induction and development of reproductive structures in plants. Symposia Soc. Expt. Biol. *2*: 104-116.

HANDLER, H. 1948. Triploid hybrids of three species of *Datura*. Amer. Jour. Bot. *35*: 708 s.

HANNING, E. 1948. Über die Kultur von Cruciferen Embryonen ausserhalb des Embryosacks. Bot. Zeitung *62*: 45-80.

HAQUE, A. 1950. The embryo sac of *Erythronium americanum* (in press).

HOLMAN, R. M. and BRUBAKER, F. 1926. On the longevity of pollen. California Univ. Publ. Bot. *13*: 179-204.

HUANG, T. 1948. Chemical stimulation in pollen germination and pollen tube growth. Bot. Bull. Acad. Sinica *2*: 282-290.

IVANOV, M. A. 1938. Experimental production of haploids in *Nicotiana rustica* L. Genetica *20*: 295-397.

IWANOWSKAYA, E. V. 1946. Hybrid embryos of cereals grown on artificial nutrient medium. Compt. Rend. (Doklady) Acad. Sci. URSS *54*: 445-448.

JOHRI, B. M. 1936. The life history of *Butomopsis lanceolata* Kunth. Proc. Indian Acad. Sci. B. *4*: 139-162.

JONES, M. D. and NEWELL, L. C. 1948. Longevity of pollen and stigmas of grasses: Buffalograss, *Buchloe dactyloides* (Nutt.) Engelm., and Corn, *Zea mays* L. Jour. Amer. Soc. Agron. *40*: 195-204.

JØRGENSEN, C. A. 1928. The experimental production of heteroploid plants in the genus *Solanum*. Jour. Genetics *19*: 133-211.

JOSHI, P. C. 1948. Self-sterility in three species of *Brugmansia*. Amer. Jour. Bot. *35*: 794 s.

KATAYAMA, Y. 1932. Haploid formation by X-rays in *Triticum monococcum*. Cytologia *5*: 235-247.

————1935. Karyogenetic studies on X-rayed sex cells and their derivatives in *Triticum monococcum*. Agri. Coll. Jour. Tokyo Imp. Univ. *13*: 333-362.

KENT, N. and BRINK, R. A. 1947. Growth in vitro of immature *Hordeum* embryos. Science *106*: 547-548.

KIHARA, J. 1940. Formation of haploids by means of delayed pollination in *Triticum monococcum*. Bot. Mag. Tokyo *4*: 178-185.

————and KATAYAMA, Y. 1932. On the progeny of haploid plants of *Triticum monococcum*. Kwagau *2*: 408-410.

KOSTOFF, D. 1934. Studies on the pollen-tubes. II, The dependence between the potency of pollen-tube growth in foreign styles and the thickness of the pollen-tubes and chromosome number. Curr. Sci. *2*: 464-466.

————1941. The problem of haploidy (cytogenetic studies on *Nicotiana* haploids and their bearings to some other cytogenetic problems). Bibl. Genetica *13*: 1-148.

KRUPKO, S. 1944. On the sterility of *Oxalis cernua* in the Mediterranean. Przyroda *1944*: 1-32.

LAIBACH, F. 1925. Das Taubwerden der Bastardsmen und die künstliche Aufzucht früh absterbender Bastardembryonen. Zeitschr. Bot. *17*: 417-459.

————1929. Ectogenesis in plants: methods and genetic possibilities of propagating embryos otherwise dying in the seed. Jour. Hered. *20*: 201-208.

LEDEBOER, M. and RIETSEMA, I. 1940. Unfruitfulness in black currants. Jour. Pomol. & Hort. Sci. *18*: 177-180.

LEOPOLD, A. C. and THIMANN, K. V. 1949. The effect of auxin on flower initiation. Amer. Jour. Bot. *36*: 342-347.

LEWIS, D. 1942. Breakdown of self-incompatibility by naphthalene acetamide. Nature *149*: 610-611.

LOVE, A. and LOVE, D. 1945. Experiments on the effects of animal sex hormones on dioecious plants. Arkiv Bot. *32A* (13): 1-60.

MAHESHWARI, P. 1944. On the longevity of pollen. Indian Jour. Hort. *2*: 82-87.

————1945. The place of angiosperm embryology in research and teaching. Jour. Indian Bot. Soc. *24*: 25-41.

MANGELSDORF, P. C. and REEVES, R. G. 1931. Hybridization of maize, *Tripsacum* and *Euchlaena*. Jour. Hered. *22*: 319-343.

MUNTZING, A. 1937. Note on haploid rye plant. Hereditas [illegible]

NAGAO, S. and TAKANO, T. 1938. Duration of the preservation of the fertilization possibility in pollen and stigma of rice plant. Comm. Papers 30th Ann. N. Akemine: 88-92.

NAGOUCHIY, 1929. Zur Kenntnis der Befruchtung und Kornbildung bei den Res ipflanzen. Japanese Jour. Bot. *4*: 385-503.

NAKAJIMA, G. 1935. Occurrence of a haploid in *Triticum turgidum.* Japanese Jour. Genetics *11*: 246-247.

NEBEL, B. R. 1939. Longevity of pollen in apple, pear, plum, peach, apricot, sour cherry. Proc. Amer. Soc. Hort. Sci. *37*: 130-132.

NORDENSKIOD, H. 1939. Studies of a haploid rye plant. Hereditas *25*: 204-210.

PAL, B. P. and SINGH, H. B. 1943. Floral characters and fruit formation in the egg plant. Indian Jour. Genetics & Plt. Breeding *3*: 45-58.

PFEIFFER, N. 1944. Prolonging the life of *Cinchona* pollen by storage under controlled conditions of temperature and humidity. Contrib. Boyce Thompson Inst. *13*: 281-294.

PINCUS, G. 1939a. The comparative behavior of mammalian eggs in vivo and in vitro. VII. Further studies on the activation of rabbit eggs. Proc. Amer. Phil Soc. *83*: 631.

————1939b. The breeding of some rabbits produced by recipients of artificially activated ova. Proc. Nat. Acad. Sci. U.S.A. *25*: 557.

————and SHAPIRO, H. 1940. The comparative behavior of mammalian eggs in vivo and in vitro. VII. Further studies on the activation of rabbit eggs. Proc. Amer. Phil. Soc. *83*: 631-642.

SACHET, M. 1948. Fertilization in six incompatible species crosses of *Datura.* Amer. Jour. Bot. *35*: 302-309.

SANDERS, M. E. 1948. Embryo development in four *Datura* species following self and hybrid pollinations. Amer. Jour. Bot. *35*: 525-532.

————and BURKHOLDER, P. R. 1948. Effect of amino acids on growth of *Datura* embryos in culture. Amer. Jour. Bot. *35*: 797s.

SANZ, C. 1945. Pollen-tube growth in intergeneric pollinations on *Datura stramonium.* Proc. Nat. Acad. Sci. U.S.A. *11*: 361-367.

SARTORIS, G. B. 1942. Longevity of sugarcane and corn pollen—a method for long distance shipment of sugarcane pollen by airplane. Amer. Jour. Bot. *31*: 395-400.

SATINA, S. 1944. Periclinal chimaeras in *Datura* in relation to development and structure, (A) of the style and stigma, (B) of calyx and corolla. Amer. Jour. Bot. *31*: 493-502.

————and BLAKESLEE, A. F. 1935. Fertilization in the incompatible cross *Datura stramonium* x *D. metel.* Bull. Torrey Bot. Club *62*: 301-312.

SKIRM, G. W. 1942. Embryo culture as an aid to plant breeding. Jour. Hered. *33*: 210-215.

SMITH, L. 1946. Haploidy in einkorn. Jour. Agri. Res. *73*: 291-301.

SMITH, P. F. 1942. Studies of the growth of pollen with respect to temperature, auxins, colchicine and vitamin B1. Amer. Jour. Bot. *29*: 56-66.

SMITH, P. G. 1944. Embryo culture of a tomato species hybrid. Proc. Amer. Soc. Hort. Sci. *44*: 413-416.

STEPHENS, J. C. and QUINBY, J. C. Anthesis, pollination and fertilization in *Sorghum.* Jour. Agri. Res. *49*: 123-136.

Stier, H. L. and de Buy, H. G. 1938. Influence of phytohormones on flower and fruit production of tomato. Proc. Amer. Soc. Hort. Sci. *36*: 723-731.

Stingl, G. 1907. Experimentelle Studie Uber die Entstehung von pflanzenlichen Embryonen. Flora *97*: 308-331.

Stout, A. B. 1924. The viability of date pollen. Jour. New York Bot. Garden *25*: 101-106.

————1944. Inactivation of incompatibilities in tetraploid progenies of *Petunia axillaris*. Torreya *44*: 45-51.

————and Chandler, C. 1941. Change from self-incompatibility to self-compatibility accompanying change from diploidy to tatraploidy. Science *94*: 118.

Svolba, F. 1942. Beobachtungen bei Pollenkeimprufungen. Gartenbauwiss. *17*: 95-105.

Thimann, K. V. and Lane, R. H. 1938. After-effects of treatment of seed with auxin. Amer. Jour. Bot. *25*: 535-543.

Tukey, H. B. 1944. The excised-embryo method of testing the germinability of fruit seed with particular reference to peach seed. Proc. Amer. Soc. Hort. Sci. *45*: 211-219.

Van Overbeek, J. 1946. Control of flower formation and fruit size in the pineapple. Bot. Gaz. *108*: 64-73.

Vasilyev, Y. P. 1937. The importance of boron for the process of fertilization. Sci. Fruitgrowing Mitchurinsk *1937*: 24-32.

Waard, J. De and Rodenburg, J. W. M. 1948. Premature flower-bud initiation in tomato-seedlings caused by 2,3,5-triiodobenzoic acid. Proc. Akad Wetensch. Amsterdam *51*: 248-251.

Yasuda, S. 1940. A preliminary note on the artificial parthenogenesis induced by application of growth promoting substance. Bot. Mag. Tokyo *54*: 506-510.

Zaitzev, S. C. 1922. A hybrid between Asiatic and American cotton plants, *Gossypium herbaceum L.* and *G. hirsutum L.* var. *laciniata*. Bull. Appl. Bot. Plt. Breeding *13*: 117-134.

Zimmerman, P. W. and Hitchcock, A. E. 1942. Substituted phenoxy and benzoic acid growth substances and the relation of structure to physiological activity. Contrib. Boyce Thompson Inst. *12*: 491-496.

————1949. Triiodobenzoic acid influences flower formation of tomatoes. Contrib. Boyce Thompson Inst. *15*s 353-361.

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SECTION OF ZOOLOGY AND ENTOMOLOGY

PRESIDENT:—B. C. BASU, D. Sc., F.E.S.I.,

Presidential Addresses

The evolution of Applied Entomology in India and its future.

"By mutual confidence and mutual aid
Great deeds are done and great discoveries made"

Ladies and gentlemen,

My first duty is to thank you and the members of the Indian Science Congress Association for the very great honour which you have done me by asking me to preside at the present meeting of the Section, an honour which I most deeply appreciate, not so much on personal grounds, as on behalf of the Indian Veterinary Research Institute. The Indian Science Congress is the only opportunity which the scientific workers of all branches in India have annually of meeting together and exchanging their ideas; as such it is essentially the most important stimulus to scientific research work in this country.

It took me quite a long time to decide what subject to choose for this address. For the past 23 years my work has centred mostly on problems of transmission of diseases of men and animals through arthopod vectors a branch of Applied Entomology and what has impressed me more and more in the study of this subject is the large and important part which workers in India have played in the development of this branch of science. I have therefore chosen the evolution of Applied Entomology in India as the subject of my address for there are many lessons from the past for the workers of the present and the future.

I have divided the subject in eight branches namely *Agricultural Entomology, Plant Protection and Quarantine Organisation, Forest Entomology, Medical Entomology, Veterinary Entomology, Entomology and lac cultivation, Entomology and Silk industry, and Bee-keeping and honey,* and have tried to briefly trace the development of each branch in India.

Before starting the actual subject matter, I would express my thanks to Dr. S. Datta, Director, I. V. R. I. for his help in various ways and to Dr. H. S. Pruthi, Plant Protection Adviser with the Govt. of India, Dr. P. K. Bose, Director, Lac Research Institute, Dr. N. C. Chatterji, Forest Entomologist, I. F. R. I., Dr. D. P. Rai Chaudhury, Deputy Director, Sericulture, West Bengal and Mr. R. N. Muttoo, Honorary Deputy Director of Agriculture, U. P. for their help in way of supplying me with material for this address.

AGRICULTURAL ENTOMOLOGY IN INDIA

Agricultural Entomology in India owes its origin to Wood Mason of the Indian Museum. Till the close of the 19th century all research and information on Indian insect pests were within the field of activities of the Indian Museum (Zoological Survey of India). Wood Mason (1884-85) carried out investigations on the Tea bug and Tea mite of Assam and on *Paraponyx oxyzalis*—a pest of rice in Burma. In 1888 Cotes carried out investigation on the wheat and rice weevils of India. Increased demand for information on crop pests of India necessitated the creation of the post of Entomologist to the Government of India and Lionel de Niceville was appointed to the post in January 1901 with headquarters at the Indian Museum. He actually started field study of crop pests. He studied the Mosquito Blight of Tea at Darjeeling where he died of fever in 1901. E. P. Stebbing carried out the Entomological work at the Indian Museum for some time. Till 1903, six volumes of Indian Museum notes on Economic Entomology were published from the Indian Museum.

H. Maxwell Lefroy succeeded de Niceville as entomologist to the Government of India in 1903. He started with the study of cotton pest of Surat. In 1905 when the Central Agricultural Research Institute was started at Pusa, Lefroy was transferred there as Imperial Entomologist to the Government of India. He studied the life histories of insects and devised control measures against insect pests. He built up a very useful collection of insect specimens. His valuable publications, namely, "Indian Insect Pests" (1906) and "Indian Insect Life" (1909) show his power of pen, energy and hard work. Lefroy left India in 1912. He visited India again in 1915-16 and wrote a comprehensive report on sericulture.

T. Bainbriggs Fletcher took up the place of Lefroy as Imperial Entomologist to the Government of India in 1913 and held that post till 1932. During Fletcher's time Insect Taxonomy received the greatest attention at Pusa. He built up a splendid library and a valuable collection, particularly of the order Lepidoptera. A number of valuable memoirs on agricultural insects were published by him and his colleagues during his period of service.

Hem Singh Pruthi took up the place of Fletcher as Imperial Entomologist to the Government of India in 1934 and held charge of that post till 1946 though for the last few years he served as Director, Imperial Agricultural Research Institute. In 1946 Pruthi left Imperial Agricultural Research Institute to take up the post of Plant Protection Adviser with the Government of India. His field of work on plant protection organisation has been shown in another chapter. During Pruthi's time considerable amount of research work on several serious pests of Indian crops had been conducted. They are Boll worms of cotton, Borers and Hoppers of sugarcane, pests of fruit, locusts, stored grain pests, tea mites etc. A large number of memoirs on insects of agricultural importance were published by Pruthi and his colleagues. Pruthi left an extensive scheme for expansion of the Division of Entomology at the Indian Agricultural Research Institute. Aiyer is acting in place of Pruthi as Head of the Division of Agricultural Entomology at the Central Institute.

Mention may be made of Howlett, Mason, Isaac, Misra, Ghosh, Dutt, Naoroji, Pradhan, Bose, Mukerjee, Lal, Samuel etc., as other workers of importance on Agricultural Entomology at the Central Institute.

Agricultural Entomology had extensive development in Provinces and States. Eminent Entomologists like Husain, Richard, Rao, Ayyar, Lal and Sen developed Agricultural Entomology in Provinces.

Importance of Agricultural Entomology.

India's average annual production of food grain is about 67 million tons but only 40 per cent of it reach the market for sale. This reduction is due to insects and rodents which cause this enormous damage. Besides damage to food grains there is enormous annual loss due to insects in the yield of sugarcane, potato, tobacco, cotton, jute and various kinds of fruits.

Agricultural Entomology at the Centre as well as in the Province plays important role in the reduction of this huge loss to the country. In this connection special mention may be made on the work of the Central Agricultural Research Institute on the biological control of the stem and root-borer of sugarcane by means of mass liberation of egg parasite—*Trichograma evanescens minutum* in the field. *Trichograma* parasites are being artificially bred in millions at the laboratory and are being utilised in large scale at a low cost of Rs. 1—12—0 for treatment of sugarcane crop per acre for one season. They have started a similar work on the control of potato tuber moth—*Gnorimoschema operculella* by an exotic larval parasite—*Bracon* (*Microbracon*) *gelechiae* imported recently from Canada. Their work on locust control is well-known.

THE PLANT PROTECTION AND QUARTINE ORGANISATION IN INDIA

To Hem Singh Pruthi, Plant Protection Adviser with the Government of India goes the credit of organising the establishment of this important branch of science in India. As is well-known, our country has been suffering from a more or less chronic food deficit ever since the last great war commenced and the latest position seems to be that the deficit is of the size of about four million tons, which has to be met immediately by an importation of food grains from abroad at enormous cost. The Government of India in the Ministry of Agriculture have been endeavouring to remedy the situation by adopting various methods of stepping up food production in the country under the "Grow More Food" Campaign by extending the area of cultivation, by providing more water, better manure and better seed. However, it should be recognised that a leaky tank never fills. Whatever the increase in crop production may be, India is subject to the incidence of various pests and diseases of crops which, on the average, bring about, in a normal year, a reduction of 10 per cent of the yields, and in some years, when they happen to appear in an epidemic form, the losses may amount to over 50 per cent. In 1943, the *Helminthosporium* disease of paddy was the major factor in causing the disastrous famine in Bengal. In 1946-47, the wheat rust epidemic caused a loss of about two million tons of wheat. The devastation that locust infestations can cause is too well-known to be specially mentioned. It has been estimated that India normally suffers, as a result of damage caused by all manner of animal pests and plant diseases to growing crops and stored grain, a total loss of about 500 crores of rupees. This includes roughly about five million tons of cereals and other food crops, and if this loss can be prevented by plant protection methods, we may expect to be well on the way to wipe out our food deficit. It was, in view of these circumstances that the Indian Famine Commission and the Food and Agricultural Organisation of the United Nations laid special stress on the importance of plant protection as being the most important single factor in stepping up food production.

Not only has this country to check pests and diseases indigenous to it, but it has also to safeguard itself against the entry of those of foreign origin, for our experience shows that some of our most harmful pests and diseases are those introduced from outside. We have, therefore, to beware of allowing foreign forms of pests and diseases of plants entering the country and complicating an already difficult situation in respect of food production. It was with a view to safe-guard the interests of the country in these respects that the Government of India established about 2 years ago an organization (now called the Directorate of Plant Protection, Quarantine and Storage) on a permanent besis, which was designed to become fully equipped, in the course of 5 years, to undertake the following functions:

1. Responsibility for the control of pests and diseases of all-India or multi-provincial importance such as locusts, army worms, smuts rusts, etc.,
2. Assisting the provinces and states in putting up plant protection organizations and undertaking province-wide campaigns against their major pests and diseases,
3. Preventing the entry of dangerous pests and diseases from foreign countries by air, sea or land,
4. Preventing the spread of regional pests and diseases from province to province, and
5. Serving as a bureau of information in regard to insect pests and diseases, parasites and predators of pests, and various noxious animals and plants.

Work to the credit of the Organisation.

1. *Locust control.* Locuct infestations in north-west India are generally found appearing in cycles. The last cycle occurred during the years 1940-1945, and the previous one during the period 1926-1931. Although the intensity of the outbreak and the density of swarms were more or less equal in both these cycles, in 1926-1931, the control measures were carried out independently by the affected provinces and states without reference to the distribution of infestation in the country as a whole, with the result that certain sparcely inhabited areas in the Rajputana desert where intense breeding generally occurs were left uncontrolled. On the other hand, during the last cycle, the Government of India had a Central Locust Control Organization which studied the infestation in the country as a whole and judiciously co-ordinated the control work in the provinces and states with the result that the outbreak was fully and efficiently controlled. During the 1926-1931 outbreak, the official estimate in regard to the losses caused by locusts in various ways (by damage to crops and pastures) and its affect on live-stock, and by expenditure on famine relief etc.) was about Rs. 7 crores. During the cycle of 1940-45, the total cost of the control measures taken by the Centre and the affected provinces and states amounted to Rs. 25 lakhs, but the damage to crops was found to be more or less neglible in view of the efficieny of control, so that the cost of control worked out at about a little over 3 per cent of the total losses that the country might otherwise have suffered on the basis of the 1926-31 data.

Whereas in the African and Arabian areas, locust infestation continued till 1948, it had practically disappeared in India by the close of 1945. It may be mentioned here that the Plant protection Directorate is a logical outcome of, and in fact, actually an expansion of the work of Locust Control Organisation, which is now a part of it.

2. *Plant Protection Work in the Provinces and States.*

Though the ultimate object of the Entomological and Mycological Sections of Agricultural Departments in provinces and states, wherever they are in existence, is the devising of practical remedial measures for various pests and diseases of crops for the benefit of the cultivators, the staff provided have usually been so limited or have other duties to attend to such as research and teaching, that it has not been possible for them to undertake control work on a large scale—and without work on a large scale, it is plain that very little impression can be made in respect of making up the general food deficit of the country.

One of the first steps taken by the Central Plant Protection Organization was the preparation of a model plant protection scheme fitted for adoption by an average province, and its circulation to various provinces recommending an immediate starting of plant protection work. The plant Protection Adviser and his Deputy Directors subsequently visited most of the provinces and after discussion with the Agricultural Officers helped them to formulate schemes suited to the conditions of various provinces.

As a result U.P., Bombay and Madras have established full fledged plant protection organisations suited to their conditions and in many other provinces fairly large plant protection schemes are under consideration. Among the states, Mysore has recently set up a good organization designed to serve the whole state. In Ajmer, Coorg and Delhi, scheme of plant protection in respect of seed-dressing of cereals, control of hairy caterpillars and grasshoppers, spraying of orchards, etc., have been in progress.

In Bombay, a campaign against the Rice grasshopper on a large scale last year in Belgaum district by dusting B.H.C. (Gammexane and Hexyclan) had the effect of saving, on the whole, a quantity of 1,98,000 mds. of paddy estimated to cost Rs. 22 lakhs over an area of 22,000 acres, which would have otherwise been lost by grasshopper damage. Over one lakh acres of jowar were found being attacked by the Decan grasshopper pest in the districts of Belgaum, Dharwar and Bijapur, but control work could not be undertaken except on a small scale in view of the lack of availability of Dusting Machines in sufficient numbers.

In Coorg, over 4,000 acres of citrus orchards were sprayed this year against leaf and fruitful resulting in greatly increased yields of fruits, and if it had not been for a want of sufficient spraying equipment, much larger area could have been protected.

In view of the fact that most of the pesticides and spraying and dusting equipment have had to be obtained from abroad, the Government of India have recently sanctioned a Central pool of spraying and dusting equipment and insecticides, so as to be readily available for transfer or loan to such of the provinces or states as may be in urgent need of them.

3. *Quarantine work.*

Several of the serious insect pests and diseases with which India is afflicted are of foreign origin. They got entrance into the country along with plant imports in the course of normal commerce. Coming under this category are the San Jose Scale of apple, the Fluted Scale of Orange, the Woolly aphis of apple, the Potato Borer, the Coffee Rust, the Tea Blister Blight and the Flag Smut of wheat; and among some of the well-known imported noxious weeds are the water Hyacinth, Lantana and Prickly Pear.

India is fortunately free at present from various other dangerous pests and ailments of crops found in foreign countries; as for example, the American Cotton Boll Weevil, the Colorado Beetle, the Wheat Stemfly Codling moth of apple, the Potato Wart disease, the South American Rubber disease, the Tobacco Caterpilar etc. As it is important to tighten the legislative cordon to keep them out of India in the interests of the country's economy arrangements are in progress to establish up-to-date fumigation stations at the main points of entry into India by sea, air and land.

As some of the diseases and pests are yet confined to particular parts of India, arrangements are under foot to prevent their spread into other provinces or states. As an instance of this kind of effort, may be mentioned the measures taken against the spread of the Fluted Scale (*Icerya purchasi*). This insect was introduced accidentally into Madras from either Ceylon or Australia along with imported plants, and was found to have developed by 1928 into a serious pest of Wattles on the Nilgiris. As the result of an importation of its natural enemy—a ladybird beetle—from California, the Madras Government successfully checked its activities on the Nilgiris by 1930. As a result of the financial crisis of 1931, that Government discontinued work on its control, on the presumption that no further attention was necessary. After about 11 years, however, it was found that the pest had not only re-appeared on the Nilgiris, but had spread to the Pulney Hills, and into Travancore, Mysore, and Coorg and had reached as far north as Poona, with the result that the Central Government as well as the Provincial and State Governments have been obliged to take control operations against it since 1946 at considerable annual expenditure. As this insect is konwn to be a very serious pest of Citrus and other fruits in California and Florida in U.S.A., it has become necessary to prevent it from reaching the citrus areas of Central Provinces, Coorg, etc.,—a work which is one of the responsibilities of the Central Government. It may be stated that, at present, the pest has been controlled to a very great extent in Madras, Travancore and Mysore, and that Coorg and Bombay are now practically free.

FOREST ENTOMOLOGY IN INDIA

To B. Ribbentrop, Inspector General of Forests, is due the credit of demonstrating the need of a Forest Entomologist. The post was sanctioned for two years and E. P. Stebbing, was appointed to the post at the end of 1900. Stebbing was prolific with his pen, and 'Departmental notes on insects that effect Forestry' began to appear from 1902 and continued till 1906. He also published popular articles in the *Indian Forester* and the

Journal of Bombay Natural History Society which ran in serial parts from 1901 to 1908. But in spite of the efforts of R. C. Wroughton, Inspector General of Forests, to obtain the prolongation of the post, it was dropped for the time being and Stebbing took the officiating post of the Superintendent of the Indian Museum early in 1903.

As a result of representation of Eardley Wilmot, Inspector General, the Imperial Forest Research Institute was established in 1906 by raising the status of Forest School at Dehra Dun and creating 6 research posts. Stebbing was appointed Imperial Forest Zoologist in April 1906 and held the office until December 1909. The post was renamed Forest Entomologist in 1922. During this period Stebbing made important preliminary surveys of the insect fauna of Sal, (*Shorea robusta*) and the conifers and contributed abundantly in the departmental publications. In 1907 he completed 'A Manual of Elementary Forest Zoology for India'. He left India in December 1909 and after his departure published in 1914 "Indian Forest Insects of Economic importance."

In December 1909 V. Subramaniya Iyer, was appointed temporary Forest Zoologist and held the post till April 1911. In October 1911, A. D. Imms was appointed Forest Zoologist and within his short term of office of 16 months, he did valuable research work and laid the formation of an authentically identified insect collection, a good library, and adequate laboratory equipment. He made contacts with entomological specialists in many countries and large collections were distributed to them. Imms' association with forest entomology at a time when a new institution was projected and funds for the expansion of entomological research had to be secured, was a most fortunate occurrence.

In August 1913, C. F. C. Beeson, was transferred from the Punjab to take over the post of Forest Zoologist. During Beeson's terms of office forest entomology made immense progress. Many insect pests of forest trees were studies and control measures devised. Particular attention was paid to the ecology of forest insect pests. The heartwood borer of sal (*Shorea robusta*), the root borer of babul (*Acacia arabica*) and various others were studied. Biological control of defoliators of teak, shisham, mulberry, deodar, and lantana and others were taken up as a special line of investigation. The insect pests of millyards, wood working industries and ordnance factories were studied and N. C. Chatterjee took up an intensive survey of the fauna of sandal tree in connection with the spike disease of sandal. Beeson published several papers on forest entomology and his last was "The ecology and control of the forest insects of India". Beeson retired in 1941 and the post of forest entomologist was taken over by J. C. M. Gardener, Systematic Entomologist at the Institute. During Gardener's term of office work was concentrated on the protection of bamboo a war problem. Gardener retired in May 1947 when A. H. Khan, took over. Chatterjee's work at the Institute since 1911 in economic entomology comprise—lac insect, sal, babul and other borers, toon fruit and shoot borer, bamboo borers, defoliators of teak, sal, gmelina, casuarina and others, champ bug, spike disease of sandal, biological control of lantana, termite control and insecticides.

The pest of the timber trade and wood using industries, as also the borers and termites that concern the Public works, Railways and Army departments have in practice formed major subject of research at Dehra

Dun and must continue to do so. The fundamental methods of control have been worked out but the new problems arising from the increasing industrialisation of India will always need special attention.

Undoubtedly more forest capital is destroyed by pests, diseases and fire than is utilised. The following examples illustrate the variation in value and extent of damage caused by some of the major pests of Indian Forestry.

1. *Hoplocerambyx spinicornis.*—the sal heartwood brorer: The recurrent annual damage has been estimated at Rs. 2½ lakhs on sal timber extracted from state forests alone; or an annual loss of 2 annas per acre on the outturn of a million acres in the United Provinces alone. During epidemics the loss rises to an average of Rs. 18|- per acre. In the peak year of the calamity which affected five forest divisions in Central Provinces, Rewa State, and much private land, the loss of forest capital was over 137 lakhs of rupees.

2. *Hypsipyla robusta* and *Pagiophloeus, longiclaris* both borers of *Cedrela toona* and *Swietenia macrophylla.* Where young plantations of these species have been written off because of borer attack, the expenditure wasted is between Rs. 15|- to Rs. 30|- per acre.

3. *Hapalia machaeralis* and *Hybloea puera,* the teak defoliators: The severest epidemics of teak defoliators cause a loss of Rs. 130- per acre in fully stocked first quality teak plantations with a royalty of Rs. 2|- per cubic feet. In such crops the normal annual defoliation is estimated at Rs. 20—25 per acre per annum. In IV or V quality teak forest with a royalty of 8 annas per cubic foot, the loss may be within 2 rupees per acre per annum.

4. *Plecoptera reflexa,* the shisham defoliator: In some of the irrigated shisham plantation this defoliator has completely frustrated attempts to grow a pure crop of shisham and failure has incurred losses of Rs. 20|- to Rs. 40'- per acre. In established crops the annual yield over 46,500 acres is reduced by a third to a half.

5. *Calopepla leayana,* the defoliator of *Gmelina arborea,* was one of the chief factors causing the abandonment of plantations in Burma, Bengal, Assam, having a capital value of over 4½ lakhs of rupees *i.e.,* a loss of Rs. 280|- per acre.

6. Spike disease of sandal, which is a virus disease transmitted by insects has caused a loss of nearly 500 lakhs of rupees in Coorg, Mysore, Madras during the last 50 years and about 10 lakhs a year now-a-days.

These illustrations should suffice to show that losses due to insect pests may be small and possibly tolerable in poor types of forests but they increase as the productivity of the forests is increased and will become more so in future.

The total expenditure on the entomological branch of the Forest Research Institute during the past 40 years is about Rs. 21,00,000. This covers research in India up to date and in Burma up to about 1928. To assess the net cost of research, one should deduct from this total the salaries of staff employed part time on educational work in the Forest Colleges and the material assets, *viz.,* the entomological collection of some 17500 species, the library, two museums which together have a very high permanent value, If this balance is regarded as an investment, on which one might expect a return of 10 per cent compound interest plus the original capital, it will be evident that the whole amount involved is less than the loss that can be caused by a single major epidemic of the Sal-Borer. It is claimed that at least one such epidemic has been prevented and controlled by knowing how to prevent it. It is concluded that the total outlay on research has thereby been recouped. All the additional knowledge gained about the control of hundreds of other pests of forests and forest products can be regarded from the financial view point as net profit available for financing future research.

MEDICAL ENTOMOLOGY IN INDIA

The development of Medical Entomology in India has a brilliant record. Formerly insects were regarded merely as causing annoyance or direct injury to man and to his livestock and crop. But at the last decade of the nineteenth century it was found out that they are responsible for transmission of a number of serious diseases of man and animal. The recognition of this fact revolutionised the methods of control of those (insect-borne) diseases. The modern methods of treatment of tropical diseases trend more and more towards the control of insect vectors as 'Prevention is better than cure'. Manson's (1878) discovery of the transmission of *Wuchereria bancrofti*—the causal organism of filariasis of man—by *Culex fatigans* at China opened the chapter of Medical Entomology. Sir David and Lady Bruce's discovery of Nagana has been referred to in connection with Veterinary Entomology. Then came the epoch-making discovery of Ross (1898) on the role of mosquitoes in the transmission of malaria. Due to the discovery of Ross in India, the importance of malaria to India and coincidentally the availability in India of a group of eminent workers that followed Ross, a large amount of solid work was done on Medical Entomology, particularly, on mosquitoes. Immediately after the discovery of Ross, a Commission to investigate the Malaria Problem was appointed and Daniel was the first member of the Commission to arrive in India in December 1898 to substantiate the findings of Ross. Stephens and Christophers other members of the Commission arrived in India in 1901 to start their Entomological investigations, and within a few years substantial work on mosquitoes were produced by Stephens, Christophers, James and Liston— all belonging to the Indian Medical Service.

In 1909, the Imperial Malaria Conference, recommended the creation of a Central Scientific Committee to carry out routine work on the distribution and bionomics of the different species of *Anopheles*. In 1910, the Central Malaria Bureau was started to carry out research work on mosquitoes and malaria. In 1911, the Indian Research Fund Association was organized with the grants from the Government of India to supervise and finance research enquiries into various human diseases and also on various important entomological subjects connected with them, namely problems on transmission and eradication of malaria, Kalaazar, Oriental sore, relapsing fever, plague, filariasis, guinea worm etc., and the works were mostly conducted at the Central Research Institute, Kasauli, Malaria Institute of India, Kasauli and Delhi, School of Tropical Medicine, Calcutta and King Institute of Preventive Medicine, Guindy. There is a long list of names of persons who conducted investigations on various enquiries on Medical Entomology in India under the auspices of the Indian Research Fund Association. They are James, Christophers, Liston, Patton, Cragg, Sinton, Covell, Shortt, Turkhud, Awati, Senior White, Barraud, Puri, Smith, Swaminath, Mehta, Mukerjee, Basu etc.

In 1922, Strickland was appointed as the first Professor of Medical Entomology at the Calcutta School of Tropical Medicine and served for a long period of nearly two decades. Roy acted in his place till his retirement.

In some of the provinces, also medical Entomology had considerable development on the Public Health side. Special mention should be made of the valuable work of Iyengar in this connection.

Arthropod Transmission of Human diseases .

The insect transmission of malaria,plague, relapsing fever, Kala-azar and guinea-worms have all been discovered by investigators in India and that is a glorious record of which any country may be proud.

In 1898, Ross discovered in India the transmission cycle of bird malaria in Culex mosquitoes and stated that a similar cycle would apply in the transmission of human malaria through the agency of Anopheline mosquitoes. In the same year Grassi in Rome demonstrated the transmission of human malaria by *Anapheles maculipennis* and experimentally infected a volunteer by mosquito bite. In India, there is a lengthy record of series of experiments on the infectivity of different species of Anophelines with malaria. In this connection special mention should be made of the works of Stephens, Christophers, James, Liston, Sinton, Bentley, Iyenger and others. Knowles and Basu (1943) and Basu (1943) carried out extensive investigations at the Calcutta School of Tropical Medicine with a grant from the Indian Reasearch Fund Association to determine for the different transmitting species of Indian Anopheles what are the limits of atmospheric temperature and relative humidity between which transmission of malaria will take place. The work started with the hope that if it can be shown that transmission is only possible between certain limits of atmospheric temperature and humidity all anti-malaria and anti-mosquito measures could be concerntrated into such periods that are climatically suiable and there would be an immense saving of labour and material in connection with malaria control; also once the limits are known the anti-mosquito campaign could be carried out with very much greater efficiency. The results were published in 1943. Chopra and Basu (1937, 1938, 1939) worked out the effect of various anti-malarial drugs upon the infectivity of patients to susceptible mosquitoes. The problem of transmission of Kalaazar from man to man had been one of the outstanding puzzles in tropical medicine for nearly a quarter of a century. In 1924, Knowles, Napier and Smith at the Calcutta School of Tropical medicine first reported the development of the flagellate stage of *Lieshmania donovani* - the causal organism of Kalazar in *Phlebotomus argentipes* the 'silver footed sandfly'. Christophers, Short, Smith and Swaminath working in Assam finally proved that P. *argentipes* is the transmitting vector of Kalaazar. In 1907. Mackie, working in Bombay found out that Asiatic relapsing fever is transmitted by body louse—*Pediculus*.

Simond in 1898 first succeeded in transmitting plague from rat to rat through the agency of flea. However, it was not till 1904 when Liston working in Bombay finally succeeded in flea transmission of plague.

Turkhud, in India, proved that a man who ingested cyclops infected with *Dracunculus medicinensis* (guinea worm) embryos showed the worms after an incubation period of 348 days.

Sunder Rao and Iyengar (1932) exprimentally found out that besides *Culex fatigans*, a number of Indian species of Anopheline and Culicine are efficient vectors of human filariasis. Basu and Sunder Rao (1939) at the Calcutta School of Tropical Medicine worked out the various factors involved in the mosquito transmission of filariasis in man.

Chopra, Basu and Sen (1939) and Basu and Sen (1945) at the Calcutta School of Tropical Medicine made a thorough investigation on rat bite fever due to *Spirillum minus* and studied its probable arthropod transmission.

The record is so voluminous on the subject of Arthopods in relation to human diseases that it may take pages to summarise it.

Survey of insects of medical importance.

There are many reports on mosquito surveys of India, most of the being buried amongst office files of the Public Health Departments of vario provinces; Sinton took enormous troubles to catalogue them all. Cov published a memoir on the distribution of Anophilines in India. Anophili and culicine mosquitoes have been mapped. Fleas, flies, human lice a sand flies have also been mapped.

Control of insects

Control of insects by various insecticides as well as by Biological contr has been tried all over the country mostly from the provincial Public Heal Departments. Special mention may be made of mosquito control work i Delhi, Bombay and Calcutta and certain rural areas of Bengal and fl control work of Bombay.

Recently World Health Organization have started an experiment Gokulnagar in U.P. to test the possibility of controlling malaria by sprayi DDT once in a year. If it succeeds it will be a great service to humanity.

Systematic Medical Entomology

In 1913 Patton and Cragg published their comprehensive Text Bo on Medical Entomology. Brunetti's work has been mentioned in con tion Veterinary Entomology. Christophers, in 1933, published a vol on Anopheline in the Fauna of India series and in 1934 Barraud publis volume on Megharini and Culicini in the same series. Prashad, Se White, Iyengar, Puri and others contributed towards the systematic s of Anopheline. Sinton published a series of articles on the systemat of Phebotomus flies of India. Puri worked on the systematics of t Simulium flies of India. Mukherjee worked on the systematics of cu coides of India. Shariff made contribution on the systematics of Fl and hard ticks of India.

Medical Entomology and its importance

Insects are reponsible for a human mortality of over one and millions a year in India. No pen can write its money value. *

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* (To quote Mackie, once His Majesty the King of England said "We Preventable disease, but if preventable why not prevented". Will our free echo it?).

VETERINARY ENTOMOLOGY IN INDIA

Veterinary Entomology in general is of recent origin. In fact it had its birth with the great discovery of Theobald Smith and F. L. Kilborne, of the Public Health Service U.S.A., who in 1893, proved beyond doubt the transmission of *Babesia bigemina,* the causal organism of the Texas Cattle fever from animal to animal through the agency of *Boophilus annulatus*—the common cattle tick. This, however, did not attract the attention it merited. Two years later in 1895, Sir David and Lady Bruce, working in Zululand under conditions of incredible hardship discovered the transmission of *Trypanosoma brucei*—the causal organism of Nagana by *Glossina morsitans*—the tsetse fly, and also worked out the transmission cycle of the causal agent of the disease. This was a discovery of enormour importance and it paved the way for a number of subsequent discoveries in this field. In 1903, Marchoux and Salimbeni proved that fowl spirochaetosis is a tick-borne disease and that the common fowl tick (*Argas pericus*) is responsible for its transmission. Subsequently a number of such discoveries came up from various countries.

In the absence of any organisation for dealing with problems of Veterinary Entomology in India, work of exploratory nature had been largely incidental to other activities of the Veterinary Department and also to those of the Medical and Agriculture Departments and the Zoological Survey of India. In 1907, Howlett joined the Indian Agricultural Research Institute as Second Imperial Entomologist and in 1912 his designation was changed as Imperial Pathological Entomologist. Isaac took up the place of Howlett in 1922. Howlett and Isaac studied the order Diptera, including those that are parasitic on domestic animals.

In 1919, Howlett worked out a scheme for the creation of a separate organization to deal exlusively with the problems of Medical and Veterinary Entomology in this country. This organisation was to consist of 10 officers and 46 assistants. The first meeting of the Veterinary Officers held at Lahore in 1917 considered and accepted the proposal. As nothing happened till 1923 the same question came up again in the second meeting of the Veterinary Officers held in 1923 and the following resolution was passed. "On account of the great importance of insects in the transmission of animal disease, as causes of direct injury to live-stock in India and the degree of specialization necessary for the proper appreciation of the various aspects of entomology, the staff of the Imperial Entomologist should be strengthened to the degree requisite for rendering assistance to investigators into the insect problems connected with animal diseases. Similarly facilities should be rendered for the establishment of a staff attached either to the Imperial Entomologist or to the Zoological Survey of India for the study of ticks and mites concerned with animal diseases". This led to the creation of a post of an Entomologist at the Imperial Veterinary Research Institute at 1933 and S. K. Sen was appointed to it. Sen's place was taken by B. C. Basu in September 1941 as Entomologist, Indian Veterinary Reasearch nstitute. Basu joined Indian Vetenary Research Institute in June 1939 s Assistant Entomologist. Basu's place was taken by B. N. Soni as ssistant Entomologist.

Indian Council of Agricultural Research financed a number of schemes on various aspects of Veterinary Entomology, such as, ox Warble fly, tick etc.

Transmission of animal diseases.

The study of the transmission of diseases of animals through the agency of arthopods has been one of the main items of investigation on Veterinary Entomology at the Indian Veterinary Reasearch Institute. Important diseases studied so far form this point of view are, Surra, rinderpest, anthrax, haemorrhagic septicaemia, theileriasis, fowl spirochaetosis and hump sore.

The attention of the Veterinary Officers in India was early drawn on the question of Transmission of *Trypanosoma evansi* - the causal organism of Surra - a fatal disease of horse, camel and mule and a chronic disease of cattle. This was the start of Veterinary Entomology in India. Rogers (1901) was the first person to test the possibility of *Tabanus* flies involved in the transmission of surra. Subsequent workers on the same problem were Baldrey (1911), Cross and Patel (1921-22), Kahan Singh (1925-26), Sen (1938) and Basu (1947). Basu at the Indian Veterinary Research Institute confirmed the Tabanus transmission of surra and proved experimental transmission of surra by *Haematopinus tuberculatus* and *Musca* (mostly *nebulo*).

Christophers (1907) and Shortt (1937), both while in Indian Medical Service, worked out the transmission of *Babesia canis* and *Pattonella gibsoni* -casual organisms of canine tick fever through the agency of *Rhipicephalus sanguneous* and *Haemaphysalis bispinosa* respectively.

Basu (1930) transmitted *Pasteurella avicida*—the causal organism of chicken cholera through the agency of *Argas pericus*. In a memoir, Knowles Das Gupta and Basu (1932) gave a through account of the mechanism of tick transmission of *Spirochaeta anserina*—the casual organism of fowl Spirochætosis and the life history of the parasite in *Argas pericus*. In a memoir, Knowles and Basu (1935) worked out the tick transmission of *Spirochaeta cobayae*—the casual organism of relapsing fever of guinea pigs, the casual organisms being first described by the same authors.

Mehra (1941) showed that healthy rabbits contracted haemorrhagic septicaemia through *Ctenocephalis felis*.

Sen and Minett (1945) succeeded to transmit antharx through *Musca domestica*. Basu (1948) transmitted anthrax through *Musca nebulo*, *Ctenocephalis felis* and *Hyalomma aegyptium*.

Sen (1926), Bhatia (1935), Kapur (1941) and Basu (1947) studied the possibility of arthopod transmission of rinderpest. Bhatia and Kapur succeeded to transmit the diseases through *Tabanus orientis* and Basu succeeded to transmit the disease through *Stomoxys calcitrans* after a period of incubation of the flies at a temperature of 22°C.

Survey of insect and acarid vectors of livestock in India.

Information concerning the distribution of arthopod vectors of ma important diseases of livestock is being obtained with a view to control eases in a particular locality in this country. Surveys carried out by the Entomological staff at Indian Veterinary Research Institute and the Veterinary investigation Officers have resulted in the finding that several important pests of livesstock are distributed over a much wider area in India than had been previously believed to be the case. *Hypoderma lineatum* and *H. crossi*—ox and goat warble flies respectively and various species of cattle ticks and Tabanid flies of India have been mapped. A few interesting findings in this direction may be mentioned here. *Hunterellus hookeri*—the tick parasite occurs in Dharwar in the province of Bombay; *Ornithodorus megnini*—the spinose ear tick has been recorded from Saugor, Mhow and Ahmednagar; *Cytoleichus nudus*—the Air Sac mite in fowls was reported from Mukteswar. The list would be of considerable size if all such names are included.

Control of insects and ticks.

Control of arthropods by insecticides, such as, D.D.T., Benzene hexachloride, Derris powder, Tobacco-lime mixture, Pyrethrum and several other preparations and by Biological methods has been under study for the past several years at the Indian Veterinary Research Institute. In the control of warble-fly successful results were obtained in the field in the Punjab by periodically singeing the hairs on legs of cattle during warble-fly season. Considerable amount of work has been done in the control of ectoparasites of cattle, sheep, goat and poultry.

Special efforts are being made at the Indian Veterinary Research Institute to artificially breed *Hunterellus hookri* on a large scale with a view to eradicate completely susceptible ticks from this country.

Bionomics, life-history and anatomical studies.

Bionomics and life-history of a number of ticks, warble-flies and other arthropods of Veterinary importance have been worked out under Indian conditions at the Indian Veterinary Research Institute as well as in other laboratories.

Machanism of feeding ticks was studied and a structure was discovered in them which is a homologue of the hypostome of insects.

Systematic Veterinary Entomology.

Considerable amount of work has been done on this aspect of the subject. Brunettii published three volumes dealing with Diptera in the series of the Fauna of India (1912, 1920 and 1923) besides a large number of articles in the Records of the Indian Museum. Patton and Cragg (1913) published a comprehensive book embodying available information on the arthropod pests of Indian livestock besides their original observations. Senior White published two useful catalogues dealing with culicidae and Tabanidae of the Indian Region. Patton (1937) published a very useful synopsis of the oriental species of *Musca*. Senior White, Aubertin and Smart (1940) published an equally useful volume on the Family *Calliphoridae* in the Fauna of Indian series. Puri (1932-35) published a series of articles on Indian simulium. Sharif (1924, 1928) made notable contribution on the Indian species of Family Ixodidae and order *Siphonoptera*. Fletcher and Sen are writing a report on Veterinary Entomology in India which when published will be of immense use to workers in the field.

Importance of Veterinary Entomology.

Over 60 per cent of the country's national income was derived from agricultural, livestock and allied pursuits, Of this the cattle industry contributed over 50 per cent roughly Rs. 2000 crores annually. The growth of India's agriculture depend largely on cattle wealth—they are nearly 25 per cent of the world's cattle.

A significant portion of mortality amongst cattle and other livestock in India can be attributed to arthropodal invasion. In live animals, moreover, they inflict a variety of damages; to mention a few of the more important, these are defective growth, decreased vigour, lowered reproductive capacity and reduced production of milk, meat, egg, wool and work. Considering the country's huge livestock population, these damages are enormous and may cost many crores of rupees annually. Hide and Cess Committee worked out a monatory loss of two crores of rupees annually to India due to damage to hide and skin caused by Warble flies.

ENTOMOLOGY AND LAC CULTIVATION IN INDIA

Lac is the only natural resin of animal-cum-vegetable origin of commercial importance. India preduces more than 90 per cent of the total world production of this important commodity.

The caccid, that produces lac as a protective covering for itself, belongs to the family *Lacifericae* and the genus *Laccifer.* The species, of the genus *Laccifer,* which produces bulk of the lac of commerce is called *Laccifer lacca.*

The lac insect not only produces the resin called lac in its crude form and shellac in its refined form but also yields a red dye at one time called crimson 'lake'.

The use of dye and some uses of resin were known from ages. But in the world at large before the aniline dyes came into market the dye had major importance. The lac dye was considered second best to that obtained from cochineal insect.

The importance of the resin grew towards the later part of the 19th century. In 1886-87 India exported 23,958 maunds of lac dye and 59,049 maunds of lac both put together valued at Rs. 19,62,394 whereas in 1939-40 for 10,27,359 maunds of lac alone India received Rs. 1,91,19,564 but the highest receipts for lac were Rs. 15,71,85,360 for 4,36,626 maunds of lac in 1920 at the close of the first world war.

Realising the importance of lac both as a peace time and war time commodity and the high prices which the consuming industries had to pay after the first world war, the then Government of India deputed H.A.F. Lindsay and C.M. Harlow to report on lac industry with a view to stabilize it. The report was submitted in 1921 and as a result the Indian Lac Research Institute came into existence and began to function from 1925-26.

Lac is found growing, naturally, on a wide range of trees and shrubs in every province and state of present day India and to a small extent in certain parts of Pakistan. But as a subsidiary and cottage industry it is to some extent cultivated in Chotanagpur Division and Santal Parganas of Bihar, States that have merged in Orissa, certain parts of C. P. Madhyabharat and districts adjoining to Bihar in Bengal and U.P. and Assam.

The cultivation of lac in all these districts and collection of naturally growing lac in other parts of India is chiefly in the hands of the poorest and most illeterate and backward classes. The manufacture and export of lac, however, is in the hands of middle class and rich Indian and European firms.

There is some sort of cultivation in the aforesaid districts but it does not receive the attention which it should even though it is a highly paying and less time consuming industry. This is one of the reasons that the annual production of crude lac in India varies between 6 and 17 *lakh* maunds.

The Institute consists of two research departments viz. Chemical and Entomological. Both the departments at first concentrated on cultivation and the problems embraced various aspects of lac cultivation. However, after 1930 the activities of the Chemical department were directed chiefly to industrial uses of lac and Entomological Department continued researches on cultivation side.

In 1936, the Indian Lac Cess Committee, started a small demonstration scheme in Bengal and Bihar. This scheme was expanded, and in 1942, the Provincial Governments of Bengal, Bihar and U.P. agreed to take part in the demonstration of improved methods of cultivation.

In India and outside certain academical aspects of the lac insect and insects associated with lac have been studied from time to time from 18th century and onwards. In India, such studies, were undertaken chiefly at the Forest Research Institute, Dehra Dun, Imperial (Indian) Agricultural Research Institute, Pusa (Delhi) and the Indian Institute of Science, Bangalore.

It is, however. at the Indian Lac Research Institute that the entire problem was and is being studied from the practical point of view.

Studies on the life history and biology of the lac insect have led to building up of a system which enables a cultivator to cut his crop at correct times, and permits management and despatch of broodlac (seed of lac) to distant places involving a journey of as long as 10 days. It may be stated that broodlac is a very costly commodity and highly perishable.

The visual system of forecasting the dates of emergence of lac larvae, evolved by the Institute, ensures vivility in broodlac, maximum possible out-put of lac by each individual female insect and hence production of maximum crops. It may be stated that each healthy female in full life produces very little lac and to produce one pound of *kusumi* lac about 15,655 and 6,580 females are required. Very frequently in the winter season when lac on *Schleichera trijuga* (kusum) trees matures, the temperature falls below the maximum optimum temperature required for emergence of lac larvae and as such the cultivators are not able to grow the succeeding crop. Under such circumstances by adopting the methods evolved by the Institute the cultivation can at least grow and obtain 40 per cent of the normal crop.

Taking all the lac crops into consideration there are about 35 per cent males and 65 per cent females. But it is the females only that produce lac worth collection. The investigations at the Institute have paved the way for producing a brood of female lac insects which asexually might produce only female progeny and thus raise the production of lac by about 20 per cent.

The chief lac hosts in order of their efficiency are *Schleichera trijuga* (kusum), *Zizyphus jujuba* (ber) and *Butea monosperma* syn. *B. frondosa* (palas).

A kusum tree as cultivated by villagers gives one crop every two to three years. The Institute has already developed and is teaching the cultivators methods of pruning which enables them to get a full crop every one and a half year. Further experiments under way promise a crop once a year.

Ber and *palas,* which form chief Rangeeni hosts and which produce about 64 per cent of the Indian lac, are deciduous and remain leafless through the greater part of summer. Hence, they do not normally sustain and carry through sufficient brood lac to maturity through the summer season. Consequently, more than three-fourths of the summer crop from these hosts is cut immature and the trees produce only about 50 per cent of the lac than they would do if they had healthy new foliage during the summer season. This state of affairs lends to frequent crop failures, acute shortage of broad lac and large fluctuations in production of lac from year to year. It is also partly responsible to high fluctuations in prices of lac. The uncertainty of sustained productions and high prices are both undesirable to the interest of the industry. More so, when we are only a raw material producing country and the consuming countries depend for its supply on us.

The Institute by its finding of partial defoliation for *palas* and partial light pruning for *ber* to grow the summer crop has to a great extent solved this difficulty of brood lac. These findings in the case of *palas* enable a cultivator to produce 7 per cent more sticklac and enable him to make a net profit of 66 per cent on brood lac against a loss of 18 per cent under the age old system of cultivation; similarly in *ber,* the cultivator makes a net profit of 29 per cent more than by his inherited methods of cultivation. Thus methods evolved will lead to growing of sustained and ever-profitable quality crops.

There are insects which destroy lac and the lac insects.. These are broadly divided into two classes, *viz.,* the predators and the parasites. The predators lodge their attack from outside the predators *Eublemma amabilis* and *Holcocera pulverea* destroy the lac insects as well as the lac, whereas the predator *Chrysopa sps.* destroy only the lac insects. The parasites are practically all chaloids and they attack the lac insect from inside the lac test and destroy only the lac insect and not the lac that it has produced before it falls victim to its parasite.

Both the predators and parasites annually destroy about 50 per cent of our productions of lac, *i.e.,* on the average about five and a half lakh maunds of lac. To reduce this colossal loss the Institute has developed cultural and artificial methods of control, *e.g.,* water-immersion, which can be easily adopted by villagers and when adopted are expected to reduce the damage to lac crops by about 30 per cent.

Further, several indigenous insects of importance to be used as biological control have been found out and life history of some of them studied in the laboratory. One of these insects, *Bracon greeni*, which is an exclusive parasite of *Eublemma amabilis* was tried in the field also and the preliminary data show considerable promise.

It may be pointed out that while the crop is growing on the trees, there is no other control method, other than the biological control, which can be adopted against the enemies of lac insects and hence its importance to check the rise of the enemy insects.

Glover, Gupta, Misra and Negi are important workers on lac insect in India.

ENTOMOLOGY AND SILK INDUSTRY IN INDIA

The commonly called silk is the bye-product of the insects of the Saturnidae and Bombycidae families. Its chemical composition is $C_{15} H_{23} N_5 O_6$. The insects producing silk are broadly classified into two divisions namely (1) mulberry-leaf feeding and (2) Non-mulberry leaf-feeding, in which there are both wild and domesticated varieties. There are about 100 different varieties of domesticated silk worms feeding on mulberry leaf producing silk of different quality and quantity as acclimatised in different countries. These worms are again classified as (1) Univoltine yielding one crop a year, (2) Bivoltine—two crops a year, and (3) multivoltine— 4 to 5 crops a year.

Endi, Tassar and Muga are the varieties of non-mulberry silk, produced by the worms *Attacus ricini* (Eri worm) *Antheraea mylitta* (Tssar worms), and *Antheraea Assama* (Muga worms) which are wild excepting Eri-worms, *Attacus ricini*, which are domesticated and feed on castor leaves (*Ricinous communis*). Tssar worms feed on sal (*Shorea robusta*), Kul (*Zizhyphes Jariuba*), Arjun (*Terminalia arjuna*) while Muga worms feed on Champa leaves (*Michelia obelouga*), Hualu (*Litsaca polyantha*).

Amongst different varieties of silk, mulberry silk is considered to be the best due to its richness in quality, universality of use and amenability to large production and practically it is the only silk with which West Bengal, Mysore and Kashmir are concerned most.

Tssar silk, which is produced in a little quantity in the western parts of Bankura and Birbhum districts, *flourishes* well in Chotanagpur and in parts of Bihar. C.P. and Orissa.

Assam is considered to be the homeland for Muga as also for Endi; but the districts of Mymensingh, Rangpur and Bogra in Eastern Pakistan also grow littlle Endi.

The silk industry existed in all its stages in India from very ancient times; but there is no authentic record when this industry developed from start to full industry. There are reports to show that Indians were well-versed in the manufacture of silk cloth since 6000 years ago. This industry is broadly divisible into two groups (*a*) Production or Sericulture proper and (*b*) Utilisation.

Sericulture is a perfect rural home industry as the main working place is the house and involving no heavy outlay of capital. Amongst all cottage

Industries it is the most important, as it perfectly fits in with the work of the agriculturists as their subsidiary occupation.

The economic value of this industry is enormous as it gives direct or indirect occupation to 2, 70,000 number of people throughout the year. Cultivation of mulberry, the principal food of the worms, is mainly done in bush form in West Bengal over 15,000 acres of lands by the Agriculturists and rearing of worms is mainly done by the inmates of their houses during the recesses when leaves are available. Worms of West Bengal being multivoltine, 4 to 5 crops per annum can be raised profitably. Cocoons, when produced, are sold to the market for production of raw silk.

Silk, the raw material of the textile industry, is produced from cocoons by a process called reeling, which is first stage of utilisation. This branch of the silk industry is both cottage and large-scale industry and gives employment to 25,000 persons in West Bengal.

Utilisation of raw silk by manufacture of fabrics is the second stage of utilisation. This section of the industry is called weaving, which is also cottage and factory industry and gives employment to 5,700 persons. Sufficient capital is required to run these two sections of the industry. Thus the three sections of the industry are entirely interdependent and require much attention and co-ordination for proper functioning of the industry. The expansion of the industry is thus entirely dependent not only upon the quick utilisation of the raw materials produced but rather upon exports to foreign market.

India previously used to export sufficient quantity of raw silk to European countries before monopolisation of the trade by Japan. Her exports reached highest level in the years 1866 and 1874 when the annual export rose to 2,203,000 lbs., but this export industry gradually decresed with increased imports of 25,00,000 lbs., of raw silk valued at Rs. 95,00,000 in 1937-38 as raw silk produced in India is not sufficient to meet the requirements of the country itself. The total quantity of raw silk production in India is estimated at 20,00,000 lbs., to 25,00,000 lbs., against her internal demands of 40,00,000 lbs., per annum as is, indicated in the following table for the year 1937-38.

TABLE

Imports (excluding less exports).	Quantity of raw silk produced and imported in India.
Raw-silk.	25,35,274 lbs.
Spun silk yarn.	15,84,289 „
Silk piece goods.	2,77,01,000 „
Mixed silk goods.	86,52,000 „

In prewar days, Japan and China were principal supplying sources. But as a sequel to various restrictions that were imposed upon silk and other textile fabrics by Japan, as also the SinoJapanese war, imports of raw silk manufactures recorded decline from 25,00,000 lbs., valued at Rs. 95,00,000 in 1937-38 to 22,00,000 lbs., valued at Rs. 62,00,000 in 1938-39.

Imports during the war period recorded decrease in minimum quantity when 44,469 lbs., of raw silk valued at Rs. 2,43,380 were exported to European countries from India in 1941-42 inspite of her deficiency in raw materials. Therefore this industry has the vast scope for development in order to meet the demands within the country itself and also to export to other countries.

The potentiality of India for this industry is very great indeed. The silk industry is sought to be maintained because it represents the high water mark of technical attainment in training, knowledge and skill amongst the textile industries. If this high standard was to die out, effect on the other flourishing sister industries such as wool, cotton etc. would be disastrous. In 1949, Government of Mysore had to arrange to import 1,00,000 lbs., of raw silk from Italy and Japan to rehabilitafe the handloom industry of the State. The immense potentiality, which India possesses should be harnessed fully for the development of the silk industry more economically and solidly to return to her past glory. Scheme on the following lines are being taken up in West Bengal for the development of this industry.

(1) Gradual replacement of bush mulberry by tree mulberry. This will cut down 60 per cent of the cultivation cost.

(2) Introduction of F1 race by replacing the indigenous races, which will also reduce the production cost by 50 per cent.

(3) Introduction of improved types of reeling and weaving machineries.

(4) Establishment of a full fledged Sericultural Training Institute for imparting Sericultural Training.

Silk industry reminds one of Pasteur's famous study of Pebrine. In 1885, the sericultural industry of the world was faced with ruin; the silk fields of France were mortally stricken with pebrine and even imported seed could not save them, for the infection had spread to Italy, Spain, Austria, Greece and even China. All stages of silk worm were infected. Appeal came to Pasteur who was so distressed by the sufferings of the peasants in the South of France that he immediately took up the problem though Pasteur was no Protozoologist and *Nosema bombycis* that causes pebrine is a protozoal parasite. Pasteur worked out a simple prophylactic measure against the disease. His plan was to crush a few insects from the batch in a little water and to examine under microscope for the refractile pebrine spores. If they were present those worms should not be kept for next years's seed. It was this discovery that saved the silk industry of the world. The income of the State in the French industry which had dropped from 130,000,000 francs a year to 8,000,000 francs, was restored. In India the pebrine problem is even more difficult than it is in France, since there are successive broods of silk worms in the year instead of only one; but the brilliant work of Hutchinson (1920) in India has shown how a more exact application of the Pasteur test may be utilised to stamp out the disease.

Ghosh, Rai-Choudhuri etc., are workers of importance on silk worm in India.

BEE-KEEPING AND HONEY INDUSTRY

The use of honey and its collection from wild hives were known to Indians long before civilization. References to honey-bee are very copious in ancient Sanskrit literature, honey being used as food and in rituals. With the advancement of civilization mankind felt the need of overcoming the difficulty and dangers involved in hunting nests of wild bees. They were induced to live in artificial shelters near human houses and men began to collect honey from those artificial combs.

Modern Bee-keeping.

In 1851, Father Langstrott of the United States discovered his novel 'movable—frame hive' which was fully utilised in the more progressive western countries. Only recently India is making use of this modern method of bee-keeping. In this the frames containing honey-filled combs can be lifted from the hive without disturbing the rest of the bees' nest. The honey from these combs is taken out by a centrifugal machine which allows honey to be extracted from them without the combs being destroyed. The emptied combs are replaced in the hive and the bees immediately re-occupy them, clean them and then start refilling them. In this method the honey is extracted without the loss of comb or bee and the honey thus received is pure, clean and unmixed with extract of larva or egg of bee. The invention of the 'Queen Excluder' makes it possible to confine the queen which is the only individual which lays eggs to one part of the hive—the 'Brooder chamber.'

Jeolikote Beekeeping Station.

The Bee-keeping station at Jeolikote in the district of Naini Tal, U.P. was started in 1938 with a small grant from the Government of U.P. under the sole charge of an amateur bee-keeper Mr. R. N. Muttoo. It has gradually grown up to an organisation of all India importance and has been the seat of research and training for bee-keepers.

Authentic publications on the subject by C. C. Ghosh, R. N. Muttoo, K. B. Lal and others are of value to the bee-keepers.

Kinds of bee in India.

Four species of bee are found in India. They are: *Apis dorsata, Apis indica, Apis florea* and the last one being Melipona belonging to the family Maliponidae.

Apis dorsata: This is the biggest of the bee. It is found in the plains as well as the lower hills. Its comb may be as big as six feet on over-hanging branches of tall trees and sometimes on rocks. Yield of 80 lbs., of honey from a single nest at one extraction has been recorded. Attempts to domesticate this bee have failed. It is vicious, fiery and vindictive in temperapent. It is popularly known as Giant bee or Rock bee.

Apis indica: This bee is easily domesticated and is used in modern bee-keeping in India. It is found both in the hill as well as in the plain. In nature it builds its nest in cavities of hollow treds, in crevices of walls, in unrerground holes and in similar situations where it is protected from the weather. It builds several parallel combs. It has a good temperament and is easily handled. Once established the same colony will continue to inhabit the same hive for years. In the wild state this species yield on an average 7 to 8 lbs., of honey per year while under domestication, with proper management, an yield of 20 to 25 lbs., of honey per year has been recorded. The honey produced by this species is of a better quality than that produced by *Apis dorsata.*

Apis florea: This species is found in the plains. It builds a single nest on the branch of some bush, hedge or similar structure. This bee is a poor gatherer of honey. A colony may yield 1 to 2 lbs., of honey in the year and as such it is not of commercial importance.

Melipona bees: This bee is not at all important to the bee-keeper. This species produces a minute quantity of honey and it is so mixed up with pollen etc., that it cannot be extracted pure.

Yield of honey in India.

A rough estimate of the total output of honey in India is placed at 50,00,000 lbs., per annum. This is only about 1|20th of the total which can be collected in India if the industry is properly organised and if bee-keeping be extensively practised. India is thus losing so much food of high energy value.

Bee-Keeping and pollination of fruit and farm crop.

Bee-keeping has other advantages also. Bee pollinates fruit and farm crops. In Russia honey bee is systematically utilised for obtaning higher yields in certain crops. In India, also bees have been reported to increase the yild of crop like 'Sarson' by about 10 per cent.

Indian Council of Agricultural Research appointed two *ad hoc* committees to study the whole question before the partition of India and are lively interested in the whole problem.

THE FUTURE.

In the history of man, insects have been responsible for more loss of life and destruction of property than that caused by wars floods, earthquakes, fires and famines combined. Their effect on the history of nations and upon affairs of the World are too well known. Had the early Romans recognized the disease - carrying habits of mosquitoes and devoted a small part of their efforts to control them, the map of Europe might have a different colour, today. The present short cut between the Atlantic and Pacific oceans might be in a different place and under different control, had the relation of mosquitoes to yellow fever and malaria been recognised a few years earlier than it was. Had the Texas fever cattle tick not been brought under control, the agriculture and dairying of the Southern States of U.S.A. would have been at standstill condition. One can cite many such instances.

All the aspects of Applied Entomology in India have been discussed, its economic values have been pointed out and its bearings on Nation's health and wealth have been stressed. I believe, its future is bright and assured in a free country.

To-day I put before you what Fletcher (1917) and Pruthi (1948) thought about the future development of Entomological subjects in India.

Fletcher (1917) submitted to the Indian Industrial Commission of 1916-18 an elaborate scheme to set up a central organization for all pure and applied work including medical, veterinary, agriculture, and forest entomology in India. This Bureau was to consist of 20 expert entomologists, 23 Entomological Assistants with necessary staff. The Industrial Commission gave their support to the scheme, but because of the poposed changes at the time in organization of the administration of the country by which Agriculture, Medicine and Veterinary became transferred subjects under the provincial Governments, and partly because of the magnitude of the scheme, it did not receive consideration from the Government of India.

Pruthi (1948) in his Presidential address in the Entomological Society of India Stressed the need for a National Entomological Laboratory for training young men for the posts of Readers and Lecturers in Entomology in the Universities and to carry out research in various branches of Pure Entomology, namely insect morphology, ecology and physiology. For its creation he suggested to urge upon the newly organised Department of Scientific Research whose function is to promote fundamental research work in all branches of science, including entomology.

It is my pious duty to put before you, on the face of facts, my plan of developmental scheme of Applied Entomology for future India. On principle I fully agree with Fletcher's scheme, of course, it will need much expansion as Fletcher's scheme was drawn up 33 years ago when conditions in India were quite different from what they are at present. There is absolute need for the creation of a Central Institute of Entomology for both pure and Applied Entomology. All the eight branches of Applied Entomology already mentioned, namely, Agricultural Entomology, Plant Protection Organization, Forest Entomology, Medical Entomology, Veterinary Entomology. Lac-Entomology, Silk-Entomology and Bee-Entomology should have fully developed Divisions for conducting basic research as well as for training of officers for Institutes of Applied Science in the respective subjects. The works of the proposed Institute will never be in competition with those of the Institute of Applied Sciences but on the otherhand, complimentary to them.

There should have a fully developed division of Pure Entomology in the Proposed Institute for conducting basic researches on Pure Entomology as well as for training readers and lecturers on Entomology in Universities as Pruthi has already suggested.

Considering the potential value of the subject in matters of national health and wealth it is for the country to judge whether to accept it or to reject it.

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SECTION OF ANTHROPOLOGY AND ARCHAEOLOGY

President: Christoph Von Fürer—Haimendorf, Ph.D.

Presidential Address

PROBLEMS AND PROSPECTS OF INDIAN ANTHROPOLOGY

To preside over the proceedings of the Anthropology and Archaeology section of the Indian Science Congress is an honour to be rated all the higher because the annual session of this Congress is the only occasion when anthropologists and archaeologists from all parts of the country assemble and discuss the progress and problems of the study of man in India. The great distances between various centres of anthropological and archaeological studies in this country deny to Indian scholars many of the advantages enjoyed by their colleagues in other countries where frequent personal contacts between the members of different universities and research institutions and the resultant mutual stimulation and constructive criticism are an essential feature of academic life.

Once a year, however, the Indian Science Congress offers a venue for comprehensive discussions on matters of common interest and I think it will therefore be fitting if I take this opportunity to review briefly some of the main problems that today face the anthropologist and archaeologist in India.

The sciences of anthropology and archaeology cover the whole range of man's existence on earth. They deal with past history as well as with present realities, and the ability of social scientists to make certain predictions regarding the behaviour of human groups draws even the future into the sphere of anthropological interest. Descriptive accounts of contemporary civilization, be they even of photographic accuracy, are therefore not an end in themselves. They provide only the raw material for anthoropological analysis and interpretation which aim at an ultimate explanation of the complexities of human behaviour and at an understanding of the development of civilizations. The ethnographer's synchronic picture of individual cultures must be complemented by the time perspective of comparative studies, particularly in countries where cultural situations are the outcome of the interaction of numerous diverse civilizations. It is in such circumstances that the diachronic approach inherent in the combination of anthropological and archaeological studies is indispensable for an explanation of present day culture patterns. Here anthropoloigcal data cannot be understood except as the result of specific sequences of events that reach back into prehistoric times, and the anthropologist cannot afford to ignore the testimony of archaeological evidence and historical documents. Even where written records are lacking it is sometimes possible to deduce from present distribution of cultures and races in space valuable evidence for their sequence in time.

In India there is a particular need for a time perspective. For here we find on a comparatively narrow space a variety of populations ranging from semi-nomadic food-gatherers to modern town dwellers. While in most other parts of the world rising civilizations tended to eradicate or assimilate earlier and less advanced culture forms, and history appears therefore as a succession of cultures, one taking over from the other, in India civilizations of very different level have co-existed for long periods. This is so because geographical conditions and historic accident have enabled some of the older and less dynamic races to avoid conflict and subsequently eclipse, by moving out of the way of ascending civilization into refuge areas difficult of access and unattractive to the bearers of advanced civilizations. Frequent repetitions of this process have resulted in an unparalleled accumulation of divergent culture types.

Although some of the archaic cultures which preceded the formation of the historic high civilizations may have met with complete extinction, elements of diverse archaic cultures still persist in more or less modified form among the primitive tribes and we may therefore be justified in assuming that some of the culture types found in present day aboriginal India can be typologically correlated with prehistoric cultures brought to light by archaeological excavations.

Let us see whether parallels to this situation can be found in other parts of the world. In Europe and the Mediterranean countries there are practically no survivals of prehistoric civilizations, because every dominant civilization imposed its cultural pattern on all peoples within its orbit and the geographical conditions did not favour the isolation of refuge areas. Older population elements were wiped out or absorbed by more dynamic peoples, and the student of life in prehistoric times has to depend almost entirely on the evidence of archaeological material. Compare with this the position in such marginal regions as Oceania and Australia. There the stone age persisted until the age of discovery and some aboriginal populations live even today in a stone-age atmosphere. The material culture of many of the aboriginal races as found by the early explorers was fundamentally the same as that reflected by the finds excavated by archaeologists. The Tasmanians, for instance, used the same 'palaeolithic' chipped stone implements as are found embedded in river gravels not only of Tasmania, but also of Southern Australia. The correlation of past and present is here complete, and 'prehistoric' cultures merge uniterruptedly into living aboriginal cultures.

India stands in this respect midway between Europe and Austrialia. A cultural development of an antiquity comparable to that of the Mediterranean civilizations has in most areas created patterns of life as far removed from those of the stone age as any in the Western world, and at the same time populations of extremely primitive racial types have persisted almost undisturbed in a style of life fundamentally similar to that of the stone age. Thus the study of archaic Indian civilizations concerns not only the archaeologist, who uncovers stratum after stratum of past cultures, but also the ethnologist, who interprets archaeological material by projecting it against the background of living primitive cultures.

Close co-operation between archaeology and anthropology is therefore an urgent *desideratum* and it is important that the potentialities of cross fertilization are recognized by the representatives of both these branches of the science of man. Yet in India a co-ordination of these two sciences is only in its beginning, and in this context I can do not more than suggest a few lines of approach to problems of common interest.

Perhaps the most important discovery of recent years in the sphere of Indian prehistoric archaeology is the identification and the dating of the neolithic and chalcolithic culture strata which preceded the megalithic culture of South India. Professor Wheeler's successful excavations in Brahmagiri have provided the key to a number of problems which had for long puzzled the archaeologist and the anthropologist interested in the early history of India. To my mind the importance of these excavations to the anthropologist is twofold: We are now able to date the megalithic culture in South India and we have for the first time a clear indication of the position of that neolithic industry which is characterized by the partly or wholly polished celt of pointed butt and oval cross section.

Stone axes of this type have a wide distribution in India, but so far they have known mainly from incidental surface finds. They occur in large numbers in many parts of the Deccan and in the eastern part of Madras Presidency. Numerous specimens have also been found in the area between the upper course of the Narbada and the Jumna, and there are several finds from Bihar, Bengal and Assam. This wide distribution suggests that the pointed butt axe belongs to a civilization which influenced large parts of the sub-continent, and the occurrence of very similar forms outside India emphasizes its importance in the culture scheme of Southern Asia.

In China as well as in Japan the axe of oval or round cross section appears to be the oldest fully developed neolithic implement preceding both the shouldered celt and the highly polished celt of quadrangular cross section. It occurs in Formosa, the Philippine Islands and the whole of eastern Indonesia, but is absent in Malaya and western Indonesia. A few specimens are known from Northern Burma and in Assam most of the neolithic axes found on the surface and obtained from the local tribesmen are of the pointed butt type. West of Assam similar types occur in Bengal and Peninsular India, but it would seem that on the whole the types found in the Deccan and South India are larger and coarser than those of Assam.

Scanty as the archaeological material may still be, the whole evidence suggests that the civilization characterized by the axe with pointed butt is the first major neolithic civilization of Southern and South Eastern Asia. Where its origin lay cannot yet be said, but we are probably justified in associating it with populations who first developed a neolithic economy, *i.e.* an economy based on agriculture and involving a style of life far more settled than of foodgatherers and hunters. While in most other parts of the world such a primitive agricultural economy of 'neolithic' type belongs to the past, in India there are numerous peoples whose culture pattern corresponds in most respects to that of neolithic man even though metal instruments obtained by trade and barter may long have replaced the earlier stone axes. These people are the primitive forest tribes who practise a system of shifting cultivation which necessitates the periodical clearing of forest growth, who use neither the plough nor wheeled transport, and who have usually no other domestic animals than dog, pig and poultry. Some forest tribes of the high ranges of Travancore and Cochin, the Reddis and the Dires of the Eastern Ghats, the Kolams and the Kamars of the Central Provinces and the Juang and Birhors of Orissa and Bihar are all typical examples of such an archaic type of agriculture.

But are we really justified in drawing a parallel between these primitive agricultural civilizations and the neolithic industry characterized by the pointed butt axe? The evidence is so far circumstantial rather than direct but much speaks, indeed for the possibility of such an equation and Professor Wheeler's excavations have provided us with a number of important new clues.

I think everybody will agree that the culture that preceded that first agricultural civilization was one of foodgatherers and hunters, such as survives still among a few small forest tribes in Southern India, *e.g.*, Chenchus, Kadars and Malapantaram. There is equally no doubt that a mesolithic culture of chipped stone implements preceded the first neolithic industry of polished axes. The coming of these axes heralded one of the greatest revolutions in the history of mankind: the transition from a food collecting to a food producing economy. For with an efficient axe man was able to clear the forest and to gain thereby the necessary space for the cultivation of crops. Palaeolithic man armed only *coup-de-poings* or flake tools was able to live *in* the forest, but he did not have the necessary instruments to carve cultivable land out of the forest. We need not resort to the speculative interpretation of archaeological finds to envisage the culture pattern of such early cultivators. Tribes living in secluded forest areas of Peninsular India exemplify the type of economy which must have followed upon the hunting and collecting stage. Though today they use iron axes, we know from experience in other parts of the world that an effective neolithic axe would enable them to carry on their primitive cultivation in much the same way, and it is reasonable to presume that the makers of the first neolithic axes, which in India and large parts of Southeastern Asia were apparently cylindrical or oval, pointed butt axes lived in similar style. The excavations in Brahmagiri showed that the stone axe people lived in more or less permanent houses and we know that such sedentary habits are usually linked with the existence of a stable food supply. In other words the stone axe people of Brahmagiri must have been cultivators and the general level of their material culture indicates that their methods of agriculture were as primitive as those of many surviving shifting cultivators.

We may thus claim to have identified traces of the earliest agricultural civilization of India both archaeologically and ethnologically, and this is more than can be said of many other countries. Moreover, we have evidence that a neolithic culture of no great elaboration persisted in South India until about 300 B.C., when a megalithic people with a fully developed iron age culture suddenly overlaid the earlier civilization. The persistence of a stone age culture until so late a date compels us to revise to some extent our ideas of India's early history.

Right up to the time of the Asokan empire large parts of Peninsular India must have been inhabited by populations comparable to the more primitive of the present aboriginal tribes, and the gap between these living representatives of cultures of neolithic 'style' and cultures of the neolithic age has now been narrowed down to about two thousand years. Considering the very great conservatism of primitive peoples—a conservatism of which prehistoric research provides such ample evidence—it is not unreasonable to assume that despite casual contacts with higher civilizations some of the present-day aboriginals have retained a good many of the characteristics of their neolithic forebears.

This situation is a challenge to Indian anthropologists and archaeologists. For it offers the prospect of tracing the entire sequence of cultural developments from the early neolithic age to present times. Such an enterprise, however, would involve a new orientation in archaeological research. We would have to excavate not in areas known as centres of ancient civilizations, but in places still inhabited by people standing on a comparatively low level of material development. It is there where a 'neolithic' economy persists into our age, that we can hope to find the immediate antecedents of aboriginal cultures.

I do not say that the discovery of neolithic sites would in all cases be easy. The sites used for habitation by some of the more primitive shifting cultivators are not always readily recognizable, and there is no guarantee that present settlements stand on sites inhabited also in ancient times. But in many areas village sites are fairly permanent because they are determined by such immutable factors as the availability of water or level space for building huts. Many of the more advanced tribes have traditional village sites some of which are certainly of considerable antiquity and would probably reward excavation. I am thinking here primarily of such tribes as the Bondos and Gadabas of Orissa, the Kotas of the Nilgiris, some of the Munda tribes of Bihar, the Khasis of the hills round Shillong, certain Naga Tribes and the Apa Tanis of the Assam-Tibet borderlands. Among many of these tribes we find besides the present villages, abandoned sites some of them reputed to have been peopled in the distant past. There is reason to believe that these sites, if systematically excavated, would yield valuable archaeological material which might enable us to link the particular tribal culture of today with prehistoric civilizations of great antiquity.

It is well known, for instance, that neolithic celts with a pointed or narrow butt and oval cross section are found in great numbers in the Nags Hills and it is significant that most finds come from places with similar topographical features. Excavations in such areas might lead to the discovery of that neolithic culture which underlies present day Naga culture. The excavation of a few such sites would be invaluable not only for our knowledge of the growth of Naga culture, but for the understanding of the prehistory of Southeast Asia.

Although we are probably justified in correlating the proto-neolithic industry of the pointed butt axes with the earliest agricultural civilizations on Indian soil, we are not in a position to link this industry with any racial or linguistic stratum. Indeed any attempt to establish such a link brings us face to face with another major problem. Considering the wide distribution of these neolithic axes in South India it would not be unreasonable to link them with the peoples speaking proto-Dravidian languages and this was indeed the hypothesis put forward by R. Von Heine-Geldern in 1928. But if already the earliest neolithic cultivators spoke Dravidian languages, what were the languages of the megalith builders of the iron age who succeeded the stone axe people? It is hardly credible that these bringers of an entirely new culture and style of living spoke languages closely akin to the language of the people whom they supreseded. If we have to chose between the possibility of correlating the stone axe people or the megalith builders with a proto-Dravidian stratum our choice must naturally fall on the megalith builders, who seem to have been the immediate predecessors of the historic Dravidian civilizations. The neolithic stone axe folk probably spoke a language of which no trace has survived, although elements of their race and culture may live on in much diluted form among some of the aboriginal tribes.

The neolithic and partly chalcolithic stone axe people were crowded out and either subjugated or assimilated by a strong wave of new comers who brought the use of iron and the custom of burying their dead in megalithic tombs. The realization that this megalithic culture flourished as late as the second half of the first millenium B.C. and that—at least in the Brahmagiri area—it overlaid a comparatively primitive culture, compels us to view the whole megalithic problem in India from a new angle.

I think that there can no longer be any reasonable doubt that in India at any rate the iron-age megalithic culture of the South had an independent development from the megalithic culture of the Northeast, which still survives among some of the hill tribes of Assam. For the spread of the megalithic culture of Southern India appears to have occurred at a time when the Gangetic valley was already firmly in the hands of Indo-Aryan populations. This confirms my opinion on the essential separateness of these two megalithic civilizations in India, an opinion at which I arrived on purely typological grounds even before Wheeler had made his discoveries at Brahmagiri. It would now seem that the Southeast Asiatic megalithic civilization which spread from Further India to Indonesia and deep into the Pacific, is the older of the two. Characterized by the use of unfashioned stones for memorials, ritual seats, dance circles, steps and avenues, it is found not only among may of the older populations of Further India and Indonesia but also among tribal peoples of Peninsular India such as some of the Bastar Gonds, Gadabas and Bondos. An overlap with the South Indian megalithic culture may have occurred approximately along the line of the Godavari. A special problem are the megalithic elements in Toda and Kota culture. Anyone familiar with living megalithic cultures in Assam and Orissa must be struck by the many megalithic features of a Kota village; how these menhirs, stone seats, stone lined dance places and small dolmens of the Kotas could be derived from the megalithic port-hole cists of the iron-age culture of Southern India is difficult to see. Typologically they appear much closer to the megalithic complex of Southeast Asia.

I have already mentioned the possibility of correlating the iron-age megalith builders of South India with the bearers of the Dravidian languages. That at some time in the first millenium B. C. the megalith builders were the dominant population in many parts of Southern India cannot be doubted, and it is difficult to imagine what tongue other than a Dravidian language they could have spoken. The occurrence of Brahui, a Dravidian language, in Baluchistan might be considered contradictory to such a hypothesis. But this one Dravidian enclave is by no means proof that the whole of Northern India was at one time occupied by Dravidian speaking populations. If such populations reached India by sea—and there is reason to believe that the megalith builders were sea-faring folk—it is very probable that they established themselves on the west coast of the Subcontinent at more than one place. Unfortunately large parts of Northwest India—or politically speaking Pakistan—are archaeological by very little known. But stone cists, though without port-hole, have been found in the vicinity of Karachi, and their patchy distribution would seem to speak in favour of a sea borne migration of megalithic folk. Brahui may have been the language of a colony whose contacts with the Dravidian speaking people of the South were mainly by sea.

However, all speculation on the original bearers of the Dravidian languages is somewhat premature so long as we are unable to reconstruct a proto-Dravidian. Unfortunately Dravidian studies are not yet so advanced and very little work is being done on any of the unwritten Dravidian languages of the aboriginal tribes. These languages, some of which are rapidly disappearing are of the utmost importance to our knowledge of pre-Aryan India, but since Professor Emeneau's successful investigations among the Kotas and Todas, no fieldwork by trained linguists has been undertaken among any of the numerous Dravidian speaking aboriginal tribes. The Linguistic Survey never covered Southern India, and nothing is being done to fill this gap. In its wider sense anthropology includes also the study of language, which after all is not only the principal means of expressing culture, but a cultural manifestation of the first order. Anthropologists therefore cannot view with complacency the complete neglect of linguistic among India's aboriginals, and it is a matter of regret that the Anthropological Department of the Government of India has not been able to organize such field studies by trained linguists, although this important item was included in the department's earlier programmes. Research on the unwritten Dravidian languages is today being carried not only in Paris, Oxford and California, but the workers in those places are hampered by the inadequacy of the recorded material, while in India invaluable evidence remains unrecorded owing to the lack of trained observers. It is only fair to mention, however the very creditable efforts of amateur linguists such as the officers of the Social Service Department of Hyderabad and certain missionaries to whom we owe grammars and word lists of otherwise unrecorded Dravidian dialects.

What are the principal problems in relation to the tribal languages of Dravidian character that concern the anthropologist? I suppose that anybody interested in the ethnology of Peninsular India must at one time or another have put himself the question whether such unwritten languages as Gondi, Kui or Kolami, can be considered the original languages of the tribes now speaking them, or whether such languages were adopted from populations more advanced in material development. *Prima facie* it does not appear very probable that populations as different in physical make-up and general culture as say the Hill Marias of Bastar and the Telugus with their great historic past should always have spoken closely related languages. When we find primitive tribes such as Bhils or Baigas speaking Aryan languages we do presume that their ancestors were among the early Aryan invaders, but take it for granted that they adopted Aryan languages under pressure from politically dominant populations. Similarly no anthropologist with some knowledge of India will assume that the Chenchus or Yanadis spoke always Telugu or conversely that the speakers of the undifferentiated proto-Dravidian languages stood on a level of culture comparable to that of the Chenchus. But when it comes to Gonds, Kolams, Khonds or Oraons, *i.e.*, tribes speaking Dravidian tongues distinct from such written languages as Telugu, Kanarese and Tamil, the position is somewhat different. Here we must exclude the possibility of recent linguistic change. The dialects of the various Gondi-speaking tribes, for instance, have undoubtedly been spoken by these peoples for many centuries and the spread of very similar dialects over large parts of the country suggests that these unwritten languages too look back upon a history of considerable antiquity. In the case of Kui, the language of the Khonds of Orissa, Professor Emeneau has proved this on purely philological grounds. This language contains certain archaic elements which have been lost in all other Dravidian tongues, including the literary languages, but which explain a good many otherwise obscure forms in the written Dravidian languages. This may mean that Kui separated from the main stem before such languages as Telugu, Kanarese and Tamil were fully differentiated or that the Khonds preserved in their mode of speech certain traits which they originally took over from the undifferentiated language of a proto-Dravidian population.

It is as yet problematic whether the Dravidian languages of the aboriginal tribes of Southern and Middle India are directly derived from a common proto-Dravidian, or whether they are the result of a process of Dravidianization comparable to the Aryanization which is still in process in the contact areas of the Central Provinces, Bihar and Orissa. That the vocabularies of certain tribal tongues contain a good many words which are without parallel in other Dravidian languages would seem to speak for the second alternative, and these isolated words may be a residue from older tongues overlaid by a Dravidian stratum. From the ethnological point of view this hypothesis has much to commend itself. It offers an adequate explanation for the racial and cultural diversity of the Dravidian speaking tribes, and enables us to understand how it is that a language like Gondi is today being spoken by people as different in cultural level as the Hill Marias, the Murias, and the Raj Gonds. If during one phase of the Dravidian expansion, a period which must have preceded the Aryan expansion, Dravidian languages were accepted by various aboriginal tribes of different custom and culture, it is quite understandable that linguistic uniformity was imposed on heterogenous groups whose cultural individuality persists even after the replacement or perhaps assimilation—of older languages.

I admit that in all these deliberations we are merely postulating hypotheses; the only way whereby we can reach firmer ground is the organization of systematic research on the unwritten Dravidian languages. Such research could be carried out most effectively by teams of anthropologists and linguists. An anthropological approach will help the linguist in the study of the social context of speech, and the linguist's assistance will be invaluable in the recording of anthropologically relevant texts. The value of such collaboration is not confined to the technical aspect of fieldwork, but extends to the interpretation of the material. Linguistic conclusions can often constitute decisive evidence on historical affinities; and the anthropologist interested in the history of India's tribal populations cannot dispense with linguistic evidence.

In this connection I may remind you of the whole problems of the Austroasiatic speaking peoples which is another unsolved puzzle of India ethnology. What are the main facts of this question? In the Central Provinces, Orissa and Bihar we find a number of languages spoken by more or less primitive tribes, which are commonly known as Munda languages. Though obviously interrelated with each other they cannot at present be connected with any of the other language groups of Peninsular India. In 1907 Professor Wilhelm Schmidt put forward the thesis that these Munda languages are a branch of a language group which includes the Mon and Khmer languages of Further India and to which he gave the name Austroasiatic. He was able to demonstrate a large number of lexical parallels as well as certain important structural similarities between the Munda languages and the Mon-Khmer group. But the material on which Schmidt based his conclusions was very fragmentary and in recent years the soundness of his thesis has been questioned on various grounds. But Schmidt's critics suffer from the same handicap of inadequate material as he did himself, and in the linguistic field no really new and constructive contribution to the Munda problem has been made for more than a quarter of a century. The attempts of Hevesey to connect the Mund languages with Finno-Ugrian languages have not been convincing, and considering the paucity of reliable material Schmidt's interpretation would seem to remain the most satisfactory explanation of the known facts. Some linguists, however, put forth the view that as long as practically nothing is known of many of the Munda dialects, such as Korku, Bondo, Dire, Gadaba, Juang and many more, it is impossible to reconstruct a proto-Munda, and that until this is done there is little point in comparing individual Munda dialects with individual languages of the equally inadequately known Mon-Khmer group.

The answer to this problem is once more systematic field research among the various Munda speakers and that again can best be done by linguists working in co-operation with anthropological field-workers. Without disparaging in the least the indefatigable efforts of those learned missionaries to whom alone we owe whatever is known on some of the Munda languages, we must remember that linguistic and phonetic studies have progressed and specialized to such a degree that the layman, however well acquainted with a language, cannot replace the scientifically trained investigator. Though texts recorded by an anthropologist may be valuable as cultural documents they are as a rule almost useless as linguistic specimens, and in this category I include my own records of texts collected among Tibeto-Burma as well as Dravidian speaking tribes.

But while from the linguistic point of view we cannot register any great advance beyond the position reached by Professor Schmidt in 1907, new evidence on the Austroasiatic problem has come forward from the archaeological and anthropological side.

The coincidence of the distribution of the Austroasiatic languages and of a certain type of neolithic celt, described alternatively as tanged or shouldered adze, was first noticed more than a quarter of a century ago and in 1928 Heine-Geldern put forward the hypothesis that people of Mongoloid affinities entered India from the east, bringing with them a highly developed neolithic culture and the languages from which the present Munda languages are derived. This immigration must obviously have antedated the Aryan conquest of India but at the present stage of our knowledge it is impossible to fix its chronological relation to the spread of Dravidian speaking populations over Middle India. While Heine-Geldern based his thesis mainly on archaeological material it has now become possible to demonstrate northeastern influences on Middle India with ethnographic data.

During my investigations among the Munda speaking tribes of Gadabas and Bondos in Orissa, I found megalithic ritual which resembles the megalithic customs of the hill peoples of Assam in such great detail that the possibility of a fortuitous similarity can be safely discounted. The megalithic complex of both areas includes the erection of menhirs and small dolmens as memorials for the dead, the building of stone circles as assembly and dance places, the use of ceremonial stone seats, the sacrifice of oxen and buffaloes in connection with the erection of memorials, and several other features associated with megalithic culture in many parts of Southeast Asia. It is impossible to link this complex with the megalithic port-hole cists of South India and the only reasonable explanation of the known facts is the theory of a movement of culture and probably also of population from the Northeast into Peninsular India. Megalithic is not the only element linking these particular hill-tribes of Bastar, Orissa and Bihar with those of Assam. The institution of youth dormitories too is common to both areas and so are various minor traits of material culture, such as for instance the peculiar bark fibre skirts of Bondo and Konyak Naga women. It would lead too far to enumerate further ethnographic parallels, but I may mention that several competent observers have noticed a slight mongoloid element among some of the tribes speaking Munda languages.

Thus we see that many of the problems of Indian anthropology cannot be solved unless we look beyond the geographical borders of the subcontinent and view them in the wider perspective of cultural and ethnic movements covering large parts of Southern Asia. Recent development of comparative anthropology in the west, suggest moreover that some of these movement extended further afield than it had hitherto been thought. That Indian cultures exerted a powerful influence on many parts of Southeast Asia has long been common knowledge, but it was unknown that such influences reached out across the Pacific deep into Central and Southern America. During the last session of the International Congress of Americanists held in New York during September 1949, a number of scholars dealt with the problem of cultural connections between Asia and pre-Columbian America. In view of the previous isolationist tendencies of most Americanists, the outcome of their deliberations is truly astonishing and must be considered a turning point in the history of the study of Old and New World relations.

At this congress it was demonstrated that relations between Asia and America extended over long periods, and relate to several independent areas to both sides of the Pacific Ocean. While the spread of certain art styles from China eastwards to America appears to have taken place before the middle of the first millenium B.C., connections between India and Middle America fall into a later period. Professor R. von Heine-Geldern, for instance, made it clear that certain striking parallels between motifs in the Hindu-Buddhist art of Southern India and the symbolic art of Mexico and the Mayan region cannot be explained except by a theory of direct transmission. These motifs, which we encounter in both areas, comprise the lotus, the *makara,* the *kirtimukha,* the cosmic tree, gods standing on crouched human figures and Atlantean figures. Close correspondence of even minor detail precludes the possibility of incidental similarity. The parallels extend also to architectural items, such as temple pyramids, railings of flights of stairs in the shape of serpents and dragon, the corbelled arch and columns in spiral form. Further examples of identical culture traits are the *pachisi* game of India and the *patolli* game of Mexico, the Indian hook swinging and the Mexican *volador,* the use in both areas of parasol, fan and litter as insignia of royalty and rank, the institution of four chief officials, and parallels in cosmological systems. All this suggests a peristent two way traffic between Southern Asia and Middle America which must have begun in the first half of the first millenium A.D. and seems to have continued for several centuries. The papers read by many distinguished anthropologists were supported by a special exhibition in the American Museum of Natural History where the influence of the Hindu-Buddhist art and architecture of southern India—particularly the style of Amaravati— on Mexico and Mayan culture was demonstrated by photographs.

Complementary to the recognition of parallel art styles and ornamental motifs, are the findings of recent botanical research into the origin of certain domestic plants. It has long been assumed that the cultivation of the sweet potato in Oceania is due to ancient contacts with America, and it has now been made probable that the bottle-gourd and certain varieties of cotton are of old world origin and have been introduced into America in pre-Columbian times. In this connection I may mention also the theory of Stonor and Anderson, who hold that maize is an old world plant which was introduced into America from Southeast Asia. This revolutionary theory is based on investigations in the hills of Assam and Burma, which seem to show that the cultivation of maize by the Nagas and other hill tribes is much older than the European influence which had previously been considered responsible for introducing maize to that part of the world.

The assumption of regular traffic by sea between South India, Southeast Asia and America in the first millenium A.D. sets new tasks to Indian scholars who might well attempt to trace the influence of Indian cultures not only in America, but also on the intervening Pacific islands.

We are only at the beginning of the study of Old and New world relations, but the interpretations of the high civilizations of Peru and Central America as the products of a fusion of Asian and American cultures opens up new fields of comparative anthropological researches.

This brief outline of some of the problems of Indian anthropology demonstrates the need for systematic and coordinated efforts by scholars specialized on different fields of study. What are the chances for such coordination and the subsequent intensification of anthropological research in India? This question is directly linked with the organization of anthropological studies in the Indian Universities. For to which institutions if not to the universities should we look for the furtherance of investigations which must be carried out over long periods by succeeding generations of scholars? Research should never be permanently divorced from teaching and teaching without the constant support and stimulation of original research is not worth the time of teachers and students and the funds provided by Government and public bodies.

The place where we are met today provides a shining example of the value of co-ordinnated research and teaching, for the Deccan College Post-graduate and Research Institute has in recent years made most valuable contributions to our knowledge of man in India. This institution, though comparatively small without great financial resources, has attained international recognition by the research schemes carried out by a group of devoted scholars. Among the universities Lucknow and Calcutta have a distinguished record of anthropological research, and Lucknow particularly has developed as a focal point of anthropological studies. In New Delhi and Madras too anthropology has recently been established, and at the Osmania University, to which I had the honour to belong for several years, anthropology is being taught in both degree and post graduate courses. But we cannot help noticing with regret that the provinces which contain the greatest numbers of aboriginals and thus offer most scope to the field anthropologist namely the Central Provinces, Orissa, Bihar and Assam provide as yet no facilities for the academic study of anthropology.

Yet it is just in these provinces that anthropologists could materially assist in the solution of problems of social readjustment and economic change. Although the application of scientific methods to an analysis of human relations is of more recent date than the scientific study of our physical environment, the achievements of modern anthropology show clearly that here we have the means of understanding the working of contemporary societies. Just as physical science enables us to predict natural phenomena, so the study of social interactions enables us to foresee many of the reaction of human groups to given events, provided we have adequate data on such relevant factors as social structure, value systems and social mobility. Indeed the practical value of social science lies largely in this capacity to provide reliable material on which to base prediction. And the ability to predict is the prerequisite for social planning.

Problems of the adjustment of primitive populations to the contact with advanced peoples have for many years engaged the special attention of anthropologists and the student of human relations investigating any particular contract situation can refer to a large volume of comparative material drawn from many parts of the world. The regularities or social 'laws' which emerge from such material will enable him to identify the trends of the social situation which he is studying and predict its probable outcome as well as the potentialities of changing the trend of events by planned intervention.

The scientific approach to social problems is one of detachment, and the social scientist must be continuously on his guard against emotional involvement. Anthropological training which necessitates familiarity with a number of different value systems conditions investigators for such detachment, and it is therefore that in countries such as the United States of America the advice of anthropologists is sought in many situations—not necessarily concerned with primitive populations—where a new and unbiassed approach to a social problem is required.

The principal field for anthropological research is, however, the primitive, pre-literate societies, and it is in this field that a highly specialized technique of enquiry and frame of references has been developed. Systems of land tenure, and kinship, tribal leadership and authority, traditional values, codes of justice and religious beliefs are all factors which the administrator responsible for the welfare of aboriginal populations cannot ignore, and for a scientific investigation of these aspects of a people's life we require the concepts worked out by anthropologists engaged in fundamental research.

In India social planning is today being undertaken on a vast scale and ambitious plans for the development of backward areas are on the programme of most Provinces and States. But as scientists we must realize that to plan the social advance and economic betterment of aboriginal peoples without adequate anthropological knowledge is as impossible as it would be to undertake a programme of public health without the advice of medical experts. There too we may know our ultimate aim, namely the good health of the people, but we are unlikely to achieve it without the knowledge of technical details which only professional training can give.

What then are the prospects for the association of anthropologists with social planning? How can their techniques of analysing backward societies be utilized for the preparation of administrative schemes and what part can they play in their execution? These questions will best be answered by giving a concrete example of the application of anthropological knowledge to an administrative problem. Anthropology has played a considerable part in shaping the future of the aboriginal populations of Hyderabad State, and I propose to outline here the development which was made possible by the application of anthropological knowledge to a scheme of aboriginal rehabilitation and education.

The aboriginal population of Hyderabad consists of a number of tribes differing widely in economic development, social customs, race and language. The most primitive are the Chenchus an ancient community of hunters and food-gatherers who lead a semi-nomadic life in the forests of the hills flanking the Kistna River. Somewhat more advanced are such tribes as the Hill Reddis and Kolams, who cultivate with hoe and digging stick on oft shifted hill fields and are only gradually taking to the more settled cultivation with plough and oxen. Finally, there are the Gonds and Koyas, peasant farmers, who form the bulk of Hyderabad's aboriginal population.

Each of these tribes lives in an entirely different style and presents different problems to the administrator. The anthropological study of several representative groups which preceded the framing of ameliorative schemes took the better part of five years, and it is indeed an indisputable fact that solid anthropological work requires a great deal of time. While it is possible to obtain during a rapid survey of an area fairly detailed information on certain selected aspects of a people's culture, the working of a social system and the economic potentialities of a population cannot be understood except by research extended over a long period. This must be kept in mind if it comes to the application of anthoropological findings to administrative problems. It is next to useless to send an anthropologist as a "trouble shooter" into an area of which he has no previous experience and expect him to submit within a few weeks practical proposals for remedying administrative difficulties or preventing imminent conflict. Before he can express an opinion on matters of policy, he must know at least the basic principles of the tribe's social organization and system of values, and such knowledge cannot be acquired within a short time. Thus the advice of an anthropologist on practical problems is only really valuable if the specific points on which he is consulted relates to populations of which he has an intimate knowledge. It is for this reason that a Government anthropologist employed on a long term basis can be far more effective than an expert engaged for a specific inquiry.

In the case of Hyderabad, schemes for aboriginal rehabilitation were framed only after extensive anthropological information on most of the tribes concerned was already available. It would lead us too far to describe in detail the entire tribal policy of Hyderabad, but a brief outline of the Gond rehabilitation scheme will show to what extent anthropological knowledge can be harnessed to the service of the administration of backward peoples.

The Raj Gonds inhabit mainly the highlands between the Godavari and Penganga River which borders on the Central Provinces. A branch of the great Gond race they were until the 18th century the ruling people in a region called after them Gondwana, but the Gonds of today are simple peasants, tilling land with ox and plough.

The synthesis of Gond and Hindu culture is of long standing and is a process which has continued with varying economic social and political emphasis over a period of many hundreds of years This on the whole 'benign' culture contact resulted in considerable accretions to Gond culture. The acceptance of such elements as the plough and the feudal system so strengthened the economic and political status of the tribesmen that they were enabled to maintain a position, if not of equality then of partnership with the medieaval Hindu dynasties of nighbouring parts of the country. Under their own rajas, they dominated a large part of Middle India throughout medieaval times, and in Adilabad a feudal system operated until the end of the last century.

During the past fifty years, however, populations from the more advanced parts of the country infiltrated into Adilabad District and their impact on the Gonds threatened to lead to the gradual disintegration of tribal life. In the wooded highlands the Gonds continued to constitute the majority of the population, but in the lowlands they lived in symbiosis with peasant communities of Maratha and Telugu stock, most of whom were immigrants of a few decades standing. These immigrants had succeeded in bringing into their possession a great deal of land previously held by Gonds. The process of land alienation, so characteristic feature of Tribal India, was facilitated by the dscrepancy between the traditional Gond system of land tenure, and the tenancy laws of the State. The Gonds accustomed to the principle of group ownership of cultivable land were slow to understand the necessity of title deeds to secure their rights on the land they tilled; Government officials ignorant of the tribal system of land tenure conferred parts of the ancestral land of Gond clans on individual immigrants, and the Gonds found themselves deprived of a large part of their heritage.

Once the situation had been diagnosed, it become clear that what was needed was drastic and immediate action: protective measures to arrest and prevent any further alienation of aboriginal land; legal recognition of the aboriginal's right on the land that they still cultivated; and new allotments to satisfy the needs of those who had already been dispossessed.

In 1944 the Hyderabad Government decided on a bold policy of land reform, and successive administration, including the present Military Government, have pursued the systematic rehabilitation of the aboriginals. A tribal zone has been created in which no non-aboriginal can newly obtain land, and large stretches of reserved forest have been thrown open for colonization by landless Gonds. All land allotted to aboriginals has been given on permanent tenure and free of charge, and old occupancy has been confirmed by the issue of title deeds.

This stabilization of Gond economy was accompaned by a psychological re-orientation of the tribesmen, for anthropological investigations had revealed that an inferiority complex, which had developed during the years of neglect and exploitation, was one of the Gonds' greatest handicaps. If they were to meet other populations on equal terms they had first to be given self confidence. This could be achieved only by education, and an education suited to the Gonds' particular needs.

The first problem was one of language, for most Gonds spoke none but their own tribal dialect, and in order to be able to hold their own among the other communities they had to learn the language most currently used in the district as well as the State language. But instruction in primary schools would have to be given through the medium of the tribal tongue, which until then was an unwritten language. It was therefore decided to train adult Gonds as school teachers and at the same time to compose basic school books in Gondi. A Gond teachers' training centre was established in a village in the heart of tribal country, and there selected young Gonds were put through an intensive training in Urdu, the State language, and Marathi, the dominant local language. Simultaneously they were taught how to teach children reading and writing Gondi in Nagri script. Today over sixty Gond schools staffed entirely with aboriginal teachers are functioning and two young Indian anthropologists are associated with the administration and development of this aboriginal education scheme.

Parallel with training of prospective teachers proceeded the composition of adult literacy charts, primers and readers in Gondi. It was particularly in this part of the work that the material accumulated during the previous anthropological study of the tribe was of considerable practical importance. For the myths, legends, riddles and songs recorded as anthropological data were used as the raw material for the composition of Gondi books. It was thus possible to produce almost immediately books in the rich idiomatic Gondi of the Gonds' traditional bards and story tellers. The added advantage of these books is the emotional appeal they make to the Gonds, who feel that the schools and the techniques taught in them are capable of giving expression to traditional cultural values. Without the co-operation of trained anthropologists similar results could hardly have been achieved. The importance of an anthropological approach to backward populations lies not only in the sphere of techniques but even more in the anthropologists' basic attitude to customs and values differing from those of his own culture. Interest and respect for the customs and cultural inheritance of other societies is a quality cultivated by anthropological teaching and it is this quality above all which is required of those called upon to guide the educational adjustment of tribal peoples to modern conditions.

The same applies to the organization of a workable system of tribal jurisdiction. Conditions in the aboriginal tracts of many parts of India are so different from those in towns and advanced rural areas, that an extension of the ordinary system of civil and criminal jurisdiction to aboriginals is often impracticable. The need in such areas for a simplified administration and procedure of jurisdiction adjusted to aboriginal societies has recently been recognized by the Constituent Assembly, which approved of the notification of special 'scheduled areas' both in Provinces and States. Hyderabad has already enacted such legislation and "Tribal Areas Regulation" provides for the exclusion of many subjects concerning aboriginals from the jurisdiction of the ordinary civil and criminal courts and for the constitution of tribal panchayats vested with both criminal and civil powers. These tribal panchayats administer traditional Gond law and are empowered to deal with all cases relating to marriage, property and inheritance. Officers with anthropological training are now engaged in collecting the data on the basis of which it will ultimately be possible to codify Gond law.

The establishment of Schedulated Areas in several Provinces offers wide scope to Indian anthropologists, but at the present time, we must view with some anxiety the discrepancy between the country's obligation to look after the welfare of 23 million aboriginal and the number of trained anthropologists available. Unfortunately we are here faced with a vicious circle: the paucity of positions offered so far by the government of Provinces and States to professional anthropologists discourages students from taking up higher studies in anthropology, while the shortage of qualified anthropologists would make it very difficult to provide suitable personnel if governments should suddenly decide to associate anthropologists to a greater extent with the administration of tribal areas.

In conclusion I should like to emphasize that anthropology is not solely concerned with the more primitive forms of society but that it can contribute to a better understanding of any society even the most advanced. Its techniques enable us to study the structure, traditional values and psychological attitudes of societies other than our own, and by furthering the understanding of foreign cultures anthropology can materially contribute to a prevention of conflicts and the growth of tolerance between communities and nations. During the war American anthropologists were entrusted with elaborate research schemes for the study of the Japanese national character and psychology, because it was recognized that one must know people before one can effectively fight them. But one must know them even better if one wants to live in peace with them.

In a country like India with its complex ethnic and cultural structure the need to promote understanding between different sections of the population and to remove thereby the sources of tension and distrust is no less than in other parts of the world. There is a wide field for the Indian anthropologist and if by objective and scientific study of social processes he can help in bridging the gap between the various communities and races he will have done work of national importance.

37th INDIAN SCIENCE CONGRESS, POONA, 1950

SECTION OF MEDICAL AND VETERINARY SCIENCE

PRESIDENT: DR. M. V. RADHAKRISHNA RAO, M.B.B.S., Ph.D., F.N.I.

Presidential address

OBSERVATIONS ON SOME COMMON DEFICIENCY DISEASES IN INDIA:

I am deeply sensible of the honour you have done me by asking me to preside over the Section of Medical and Veterinary Sciences of the Indian Science Congress this year. I wish to take this opportunity to express my most cordial thanks to you for electing me to this office, which was held before by distinguished Scientists in this field.

DEFICIENCY DISEASES IN INDIA

In a Country like ours, where famine and pestilence are frequent and ignorance and religious superstition are rife, it is not surprising that the incidence of diseases due to faulty nutrition or undernutrition is high. With the advent of the newer knowledge in the field of nutrition, several conditions which had remained obscure before, were traced to deficiencies in the diet. Since the discovery of vitamins, the emphasis was mostly on avitaminoses conditions resulting from the deficiency of one or more of the known vitamins. Thus, the existence of deficiency diseases such as Keratomalacia, Beri Beri, Scurvy, Rickets, Osteomalacia etc. has been well established. Recent researches have, however, shown that there are some clinical entities which are commonly associated with malnutrition in India but the existence of which is not so widely known as the deficiency diseases mentioned above. I propose to briefly discuss with you to-day some of these clinical conditions associated with malnutrition.

I had an unique opportunity of working without interruption in this field of the study of deficiency diseases during the last 15 years and the observations made in this address are based on my personal experience. During my recent visit to the United Kingdom and the United States of America, I had a further opportunity of confirming some of my earlier observations made in this Country regarding the aetiology and treatment of some of the Clinical entities associated with malnutrition, described below:

CUTANEOUS MANIFESTATIONS IN DEFICIENCY DISEASE

I shall first take up cutaneous manifestations in food-deficiency disease. A follicular keratosis of the skin has been described occurring in association with xerophthalmia and keratomalacia by Frazier and Hu (1930, 1931) in China, Loewenthal (1933 a and b) in East Africa, and Nicholls (1933) in Ceylon. Nicholls (1933, 1934, 1935 and 1936), who described the condition among poorly fed labourers in East Africa and also among convicts in a jail in Ceylon, gave it the name of phrynoderma (toad-skin). During the course of an investigation to study the nutritional status of school children in south India, it became apparent (Aykroyd and Rajagopal, 1936) that a similar condition was present in malnourished children.

The popular cutaneous lesions are present mostly on the extensor surfaces of the arms and thighs and are roughly symmetrical in their distribution. In some cases they are also present on the posterolateral aspect of the forearms near the elbows, on the extensor surface of the upper part of the legs, the posterior axillary folds, in between the scapular region, and across the buttocks and flanks. The papules vary in size from a big pin's head to a millet seed and are rounded or hemispherical in outline, with sharply defined edges. Examination with lens shows that the papules are situated at the site of the pilosebaceous follicles, which often show a central keratotic plug. The onset of the papular lesion is insidious, and there are no subjective symptoms. It is usually associated with a dry and slightly rough skin and occurs in children of both sexes as well as in adults.

Clinical examination of individuals showing phrynoderma reveals a poor general condition, usually xerosis or discoloration of the conjunctiva, and often dry hair. Other associated deficiencies, such as angular stomatitis, are found in some instances.

Examination of skin sections obtained by biopsy showed a superficial hyperkeratosis of the epidermis and hair follicles marked dilatation of the funnels of the pilosebaceous follicles by keratotic plugs, atrophy of the sebaceous glands, and impaired function of the sweat glands (Radhakrishna Rao, 1937 a).

Our experience in India has been that most of the people showing the papular cutaneous lesions belong to the poorer classes, whose diet consists mainly of milled rice, a small quantity of various kinds of pulses and vegetables with condiments, and perhaps a little millet. "Protective" foods such as milk, milk products, meat, eggs, and so forth, are consumed only in very small quantities occasionally or not consumed at all.

I have discussed the clinical manifestations and the histological findings in phrynoderma in some detail as there is still some uncertainty as to whether the condition is due to a simple deficiency of vitamin A or whether the etiological factors include multiple deficiences. The histological findings in phrynoderma described above, namely, the primary noninflammatory hyperkeratosis of the epithelium of the epidermis and hair follicles, the involvement of the cutaneous glands and hair derived from the ectoderm, and the absence of vascular changes or hemorrhages in the perifollicular tissues, strongly suggest that the condition is a manifestation of a nutritional deficiency in which lack of vitamin A is an important factor. The evidence presented below also supports this view.

Several workers who did not limit their clinical observations on human keratomalacia to the eye have described changes in the skin as part of the syndrome. A dry, harsh, and scaly condition of the skin is usually noticed in patients attending the hospitals in south India for the treatment of keratomalacia. It was thought that a study of the histopathological features of the skin in patients showing eye lesions characteristic of vitamin A deficiency might throw light on the etiology of the follicular keratosis, or phrynoderma. Briefly described, the principal microscopic changes consist of a superficial hyperkeratosis of the epidermis extending into the mouths of the pilosebaceous follicles, atrophy of the sebaceous glands, and slight atrophic changes in some of the hair follicles (Rradhakrishna Rao, 1937 b). These skin lesions resemble those described in phrynoderma, and the advanced follicular lesions found in the latter differ from the former only in degree and not in quality. It thus appears that the popular lesions represent a late stage of the dry and rough skin.

Further support to the view that vitamin A deficiency is an important factor in the etiology of phrynoderma is given by the results of the clinical investigation of the effect of Vitamin A concentrate on the papular eruption (Radhakrishna Rao, 1938). School children who showed marked evidence of phrynoderma were given vitamin A concentrate (preparation A of the Glaxo Laboratories, England) by mouth in doses of 10,000 to 18,000 I.U.'s of Vitamin A per day over a period ranging from 50 to 140 days. During this period no alteration was made in the diet and no local medication was applied. The beneficial effect of the treatment is illustrated by lantern slides in two cases, both of which showed marked follicular lesions. In both instances the follicular lesions had disappeared after the administration of about 16 cubic centimeters of the concentrate (each cubic centimeter of the concentrate, which contained no added vitamin D, had a potency of 72,000 I.U.'s of vitamin A).

To summarize—Vitamin A deficiency appears to be the predominant factor in the causation of the follicular keratosis of the skin associated with malnutritional states. Other factors, such as secondary food deficiencies, deficiency of essential fatty acids, the stage of sexual development a familiar need for abnormally large amounts of vitamin A, or a racial susceptibility (as suggested by Bicknell and Prescott, 1947), may perhaps influence the development of the lesion.

NUTRITIONAL DIARRHOEA

The next subject which I wish to discuss is nutritional diarrhoea. The belief that sprue is not a separate clinical condition but an assembly of clinical phenomena due to damage to the mucosa of the small intestine (Manson-Bahr, 1941) appears to be gaining ground. Chronic jejuno-ileal inefficiency may be produced by a number of diverse surgical and medical conditions, *e.g.,* gastro-jejuno-colic fistula; ulceration of the ileum, blockage of the lymphatic supply of the bowel (as in tabes mesenterica, lymphadenoma, lympho-sarcoma of the mesenteric glands); malignant disease of the small gut. The importance of deficient diet in the production of chronic jejuno-ileal inefficiency has not however, received adequate attention.

Cases of chronic diarrhoea of obscure etiology which do not respond to any kind of present treatment and slowly waste away and die are seen in hospitals in South India. No systematic investigation of this condition has been carried out, and hence it was thought desirable to study experimentally the effect on monkeys of long continued feeding on poor rice diets resembling those consumed by human beings in India.

During the course of the investigation, 84 monkeys were used, and the experiment was continued for 3 years. The animals on the poor rice diet became progressively weak, lost their appetite, and developed watery diarrhoea. The stools were small pale and contained undigested food. In untreated cases, the animals became steadily worse and died. Addition of milk, sprouted grain and banana to the basal diet improved the condition in the early stages, although these supplements had no effect in the later stages of the disease. By a judicious administration of the supplements when the animal was sick and withdrawing them as soon as the condition of the animal had improved, a chronic deficiency state was produced in which the dominating clinical sign was diarrhoea. In addition, the animals showed various symptoms indicative of vitamin deficiencies. Laboratory investigations made during life showed hypochlorhydria and hypochromic, microcytic anaemia.

On postmortem examination, the jejunum and ileum showed varying degrees of atrophy, this being more marked in the lower part ileum, from about 10 to 12 inches above the ileocaecal valve. Histological examination showed that all the different coats of the small intestine shared in the degenerative process, the mucosa being worst affected (Radhakrishna Rao, 1942).

In contrast to this, the control group of animals fed on a fairly well-balanced diet based on whole wheat, milk, vegetables, pulses, and fruits, resembling that consumed by certain races in North India, showed no demonstrable changes in the small intestine.

A clinical picture similar to that shown by the ill-fed monkeys was reported by McKenzie (1940) in African laborers subsisting on very poor diets. The gastrointestinal symptoms and the microscopic appearances of the gut in these cases were closely similar to those described in the monkey. With improvement in the diet and living conditions on the estates, McKenzie reported that the incidence of nutritional diarrhoea among estate laborers fell remarkably.

During our investigations in the Relief Camps in Bombay Province during the last one year, we had an opportunity of studying a similar condition in displaced persons. The largescale migration of the population from one dominion to the other since the partition of the country had resulted in several problems, one of which was to provide adequate diet to the displaced persons. Before these persons had actually settled down in the relief camps and relief measures were organised, they were existing, for varying periods, on poor diets. The result was that cases of Nutritional Diarrhoea were not infrequent especially during the beginning of last year (1949). In one camp which housed poor destitutes, the incidence of diarrhoea was very high indeed.

Examination of stools showed no parasitic infection and there was no evidence of any infection by pathogenic organisms. Diarrhoea was controlled by the simple dietetic treatment which included administration of butter milk and over-ripe bananas. Once the diarrhoea was controlled the patients were given whole yeast tablets and a nutritious diet. The response to treatment was quite encouraging.

It is gratifying to note that since the introduction of relief measures in the camps and with improvement in the diet and the living conditions in the camps, there was a gradual reduction in the incidence of, and mortality from Nutritional diarrhoea.

To summarize—Clinical experience and experimental work has shown that the health of the small intestine is dependent on good nutrition, and deficient diet may produce irreversible changes in the gut.

HYPOPROTEINAEMIA

Measurements of plasma proteins were made in the beginning of nineteenth century, but it is only recently that the plasma proteins have acquired linical significance. Of the various causes of this condition, some of which are unconnected with nutrition, the one most prevalent in India is undoubtedly due to the deficient intake of proteins for economic and other reasons. The albumin fraction is the one significantly disturbed in malnutrition.

This problem was also studied in the displaced persons in Relief Camps in Bombay Province. The deficiency-state manifests itself by oedema of the subcutaneous tissues, sometimes general anasarca and ascites, and is associated with varying degrees of anaemia. Haematological examination revealed anaemic condition and lowered plasma protein level in the majority of the cases. Cases of nutritional oedema of this type, though a late manifestation of hypoproteinaemia, were found to improve remarkably with high protein diet alone. The cases so treated showed clinical and haemolotogical improvement. A few cases of nutritional oedema with anaemia, treated with the usual liver extract and other routine dietetic and medical treatment, did not show similar improvement.

The Western workers favour the use of protein hydrolysates to be given orally or parenterally. In general the predigested protein preparations have nasty odour and an unpleasant taste producing nausea at times. Patients are usually reluctant to take the prescribed quantity. In view of this, we thought of utilising dried milk or egg proteins such as Skimmed Milk or whole milk powder &|or egg powder in the preparations of 'chapatis'. Our idea of using proteins in the powder form with 'atta' is perhaps a novel one but our experience encourages us to proceed in this direction and shortly to come forward with some definite conclusion about the quantity and mode of its use.

CIRRHOSIS OF THE LIVER

Investigations carried out in South India showed that dietetic deficiencies are important factors in the causation of the disease (Radhakrishna Rao, 1936, 1937). For a long time little attention was paid to the role of nutritional factors in the causation of hepatic cirrhosis, and only during recent years has the subject engaged the attention of both research workers and clinicians. In view of the topical interest, I shall briefly describe the different clinical types of cirrhosis of the liver met with in India and discuss the etiological factors with special reference to nutritional deficiencies.

Portal cirrhosis of the liver is commonly seen in the poorer class of people in the third and fourth decades of life. The disease is characterized clinically by emaciation, secondary anemia, subicterus, dry skin, atrophic liver, enlarged spleen, prominence of superficial abdominal veins, and ascites. Histologically, the parenchyma of the liver is divided by a collagenous connective tissue network into rounded islands of various sizes containing two or more of the so-called lobules.

From a careful investigation into the personal histories of 120 patients in one series, it became evident that most of the males and all the women and children in the series had never touched alcohol in any form. But some of the male patients occasionally indulged in toddy (fermented palmyra juice) or country-made marrack, and rarely, brandy on festive occasions. In no case was there a history of continuous alcoholism. Most of the patients were nonvegetarians. Dietary studies revealed an excess of carbohydrate in the diet and a deficiency of protein, fat, and vitamins, especially vitamins A, B complex, and C. In general, the diet contained an excess of chillies.

The disease is insidious in its onset, runs a protracted course, and ends fatally. It is not uncommon in children belonging to the poorer classes, and the clinical and pathological manifestations in children are similar to those seen in the adults.

In marked contrast to the portal cirrhosis, a progressive and rapidly fatal cirrhosis of the liver is commonly seen in the children, between the ages of 1 and 3 years, of middle and rich class vegetarian Hindus. The disease is characterized in the early stages by a progressive, persistent, and painless enlargement of the liver, irregular intermittent fever, and constipation, and in the later stages, by gradual contraction of the liver, jaundice, enlargement of the spleen, and ascites. Histologically, the liver shows subacute necrosis of the parenchyma, extensive obliterative lesions of the smaller divisions of the hepatic venous tree and replacement fibrosis; attempts at regeneration of the hepatic parenchyma are usually marked.

The disease takes a high toll of life among Indian children, and its causation is still not clear. Although the children affected with the disease belong to the economically better classes, dietary deficiencies are common both in the nursing mother and in the child, on account of the imposed religious restrictions. Protein of animal origin, *e.g.*, meat or fish, is not consumed by the orthodox section of the Hindu community. It is, therefore, of interest to study how far protein deficiency is related to hepatic lesions in general and production of cirrhosis of the liver in particular.

The irregular intermittent fever and leucocytosis in the early stages of the disease, its progressive nature, rapid course, and fatal termination suggest that the disease may be of the nature of a subacute infection (? virus). This and other problems await solution.

At present, an experimental investigation is in progress in the Department of Nutrition, Haffkine Institute, Bombay, to study the role of nutritional factors in the production of hepatic cirrhosis. This investigation was mainly designed to study the effect of continued feeding of diets containing varying levels of protein (purified casein 5 to 18 percent) and deficient in vitamins of the B2 complex on the histological and biochemical changes in the liver of rats. In addition, clinical studies are also in progress to study the effect of high protein diet supplemented with yeast on the course of decompensated portal cirrhosis. Although it is too early to draw definite conclusions, the clinical studies indicate that a good nutritious diet has a beneficial effect on early decompensated hepatic cirrhosis.

Twenty patients were treated with high protein diets which included skimmed milk powder, egg protein, fresh milk and casein hydrolysates. Vitamin supplements were given in the form of yeast tablets with injections of vitamin B2 complex and liver extract in some cases. The majority of the patients came from the poorer classes and their dietary histories revealed gross deficiency in calories, protein and vitamin intake.

The level of serum proteins was estimated before, during and after treatment as this afforded an objective evidence of the course of the disease. Total protein, albumin, globulin and euglobulin content of blood serum was estimated. A common observation in all the patients before treatment was the fall in albumin and rise in globulin fraction of the serum proteins, thus showing an altered albumin|globulin ratio from the normal. In the globulin fraction, the Euglobulin showed marked increase.

The period of observation during treatment was on an average 5 to 6 months. The results of therapy at the hospital have been quite encouraging. Patients treated with high protein diet showed definite clinical improvement. Ascites, oedema and other manifestations of the disease disappeared in many instances. Clinical improvement was attended with a change in the serum protein level towards normal values.

In addition to the serum proteins, the phospholipoid partition of serum of patients with cirrhosis of the liver was also studied. A marked reduction of the total phospholipoids, particularly choline-containing phospholipoids, has been found to be an important feature of all cases of cirrhosis of the liver with ascites. As a result of treatment and with clinical improvement, the choline-containing phospholipoids of the serum showed an increase. This work on the phospholipoid partition of serum in cases of cirrhosis of the liver, before and after treatment, is in progress.

To summarize—Portal cirrhosis in India is associated with nutritional deficiencies, and clinical trials suggest that a good nutritious diet may have a beneficial effect on the clinical course of the disease, if treatment is instituted early in the decompensated stage.

TROPICAL ULCER

The last condition to which I wish to draw your attention is "tropical ulser" or "Naga sore". During recent years, it has become increasingly evident that malnutrition plays an important part in the rapid spread and delayed healing of the ulcer.

The ulcer is generally single, unilateral, and present on the dorsal or lateral aspect of the lower third of the leg or foot. It varies in size from 1 to 4 inches in diameter, with sharply-cut and undermined edges. The base is covered with an ashen-gray slough, and there is abundant offensive discharge.

The occurrence of tropical ulcer has long been noticed among the coolie population employed on tea plantations in Assam (Roy, 1939) and coffee plantation in Coorg in South India (Bopaiya and Radhakrishna Rao, 1942). In both area, malaria hookworm, and anemia are prevalent, and there is much malnutrition. During the last World War, when scarcity conditions were prevalent in certain parts of India, the incidence of tropical ulcer greatly increased, and cases were reported in areas where it was not evident before (Panja and Ghosh, 1944, Radhakrishna Rao, Colah, and Kalle, 1945). Phagedenic ulcer, particularly "Naga sores" were seen in starving and sick famine victims in Calcutta and its suburbs. Similar cases were seen in large numbers in one of the districts in the Bombay Presidency.

Most of the patients whom we investigated were poorly nourished, and some of them showed evidence of vitamin deficiencies. Treatment consisted of rest in bed, good food, shark-liver oil and fresh lime juice by mouth, and external application of a "water-in-oil" emulsion containing sulfathiazole and cod-liver oil. Under this regime, the ulcers healed rapidly, and there was improvement in general condition.

Since the Government began taking adequate measures to improve the nutritional status of the general population by a system of rationing of essential food-stuffs and equitable distribution, cases of tropical ulcer have gradually declined in number, and it is now exception rather than the rule to see a case.

While the importance of trauma in the onset of the ulcer and the effect of chronic debilitating diseases such as malaria and ankylostomiasis and unhygenic conditions cannot be minimized, the evidence presented above suggests that malnutrition is an important predisposing factor.

The importance of malnutrition in the rapid spread and the delayed healing of the ulcer has not sufficiently attracted the attention of the clinicians. Apart from the specific local treatment of the ulcer, attention should therefore, be paid for improving the general nutritional state of patients suffering from this condition.

To summarize—The greater incidence of tropical ulcer in certain parts of India in recent years has been attributed to the scarcity conditions prevalent in these areas, and it is suggested that malnutrition plays a part in the causation of the condition.

I have given you an account of some of the common diseases associated with malnutrition in India. The list is neither complete nor exhaustive. There are a number of other deficiency diseases which are equally important, but time does not permit me to discuss them here. The prevalence of such diseases illustrates the magnitude of the problem of nutrition in our country.

BIBLIOGRAPHY

Aykroyd, W. R., and Rajagopal, K. ..Ind. Jour. Med. Res. 24:419, 1936.

Bicknell, F., and Prescott, F. ..The Vitamins in Medicine, Grune and Stration, New York, 1947.

Bopaiya, M.S., & Radhakrishna Rao, M.V. ..Ind. Med. Gaz. 77:139, 1942.

Frazier, C. N. and Hu, C. K. .. ..Compt. rend. Cong. Internat, de dermat. et de syph. 482, 1930.

Frazier, C. N. and Hu, C. K. .. ..Arch. Int. Med. 48:507, 1931.

Loewenthal, L. G. A. .. ..East Afr. Med. Jour. 10; 58, 1933a.

Loewenthal, L. G. A. .. ..Arch. Dermat. and Syph. 28, 700, 1933b.

Manson-Bahr. .. ..Trop. Dis. Bull. 38:123, 1941.

McKenzie .. ..East Afr. Med. Jr. 17:30, 1940.

Nicholls, L. .. .. ..Ind. Med. Gaz. 68:681, 1933.

Nicholls, L. .. .. ..Ind. Med. Gaz. 69: 241, 1934.

Nicholls, L. .. .. ..Ind. Med. Gaz. 70:14, 1935.

Nicholls, L. .. .. ..Cey. Jour. Sci. 4:1 (part 1) 1936.

Panja, D and Ghosh, L. M. .. ..Ind. Med. Gaz. 79:17, 1944.

Radhakrishna Rao, M. V. .. ..Monograph on 'Cirrhosis of the liver in Northern Circars South India'. Jour. Ind. Med. Assoc. Dec. 1936, Jan.-July, 1937.

Radhakrishna Rao, M. V. .. ..Ind. Jour. Med. Res. 24:727, 1937a.

Radhakrishna Rao, M. V. .. ..Ind. Jour. Med. Res. 25:39, 1937b.

Radhakrishna Rao, M. V. .. ..Ind. Med. Gaz. 73. 461, 1938.

Radhakrishna Rao, M. V. .. ..Ind. Jour. Med. Res. 30:273, 1942.

Radhakrishna Rao, M. V., Colah, R. B. M. and Kalle, R. A. .. ..Ind. Med. Gaz. 80, 128, 1945.

Roy, D. N. .. .. ..Brit. Encyclopaedia of Med. Practice 12:256, Butterworth and Co. Ltd., London, 1939.

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SECTION OF AGRICULTURAL SCIENCES

PRESIDENT: R. L. SETHI., I. A. S.

Presidential Address.

PLANNING FOR AGRICULTURAL DEVELOPMENT IN FUTURE

Gentlemen,

I consider it a proud privilege to preside over the meeting of the Agricultural Section of the 37th Session of the Indian Science Congress and thank the committee for the honour they have done me by electing me the President. I am conscious of my shortcomings as in spite of my long service of 27 years in the Agricultural Department I still feel diffident in taking up the leadership of deliberations on this important subject at the annual gathering of the premier scientific organization of the country. But I hope that with your kind cooperation and help I shall be able to discharge my duties satisfactorily.

HISTORICAL

The subject of my talk is a vast one and one can go on speaking on it for hours without finishing it, but I will restrict my observations briefly to only a few salient problems that need attention for bringing about the desired agricultural development in the country in future. Agriculture, as we know, is the main industry of the country and the welfare of more than 3|4th of the population depends upon. The present day sufferings and shortcomings of the people are due to the serious neglect shown in this industry in the past in all its phases. Before attempting to discuss the future problems, it seems necessary to give an account of the historical background that brought into existence the present state of affairs. I do not want to go very far behind but just to the period before the British rule in India. Agriculture at that time was adjusted with the then village economy. Each village was more or less a self-contained unit. It produced most of the articles it needed for its requirements locally. People grew food crops sufficient enough for their needs, grew cotton and made their own *khadi* cloth, grew cane and made *gur* and other sweets out of it, grew oilseed crops and produced oil with the help of village ghani for use both for culinary and burning purposes. They reared cattle both for milch and draught purposes. In short each village was self-sufficient in its requirements. In the absence of railways and other modern means of communication people had to depend on whatever they could produce locally and therefore tried to become as much self-contained as was possible within the limits of available facilities. They had less wants and were contended and it was then that India was known to be flowing with honey and milk. The rates of a few essential articles as prevailing in the beginning of the British period and later, as reported by Mr. B. D. Verma, retired

Manager, Military Dairy Farms, in his book called Gopalan, page 368, were as follows:

	1857	1890	1918	1949
	(Seers per rupee)	(Seers per rupee)	(Seers per rupee)	(Seers per rupee)
(1) Milk	160	64	4	1.2
(2) Wheat	39	25	5½	2
(3) *Ghee*	8	1½	½	1|6

With the advance of British rule, the old order changed and the village economy was upset. Greater stress was laid on the production of such raw materials as were needed in England and other foreign countries for manufacturing consumer goods. Agriculture was exploited to that end and more attention was paid to cash crops which brought more money to purchase more goods than food crops. Whatever shortage of food was there, it was met by import from Burma, Australia, Russia and other countries. Indian markets were flooded with foreign goods and the articles became so cheap and abundant that it became impossible for the village produce to compete with them. This process continued for over 150 years of British rule in India and during this period people lost all taste for the village-made crude articles and preferred fine goods turned out by machinery. The import of finished goods and food from abroad brought forth such a great amount of unemployment in the villages that even to earn Rs. 12 a month a villager had to go in search of employment to the city. It was at this stage that Mahatma Gandhi, accentuated by feelings of extreme poverty and helplessness of villagers, started the *Swadeshi* Movement and introduced *Satyagraha*. Although under pressure of political forces, Government allowed the development of some industries, still these industries being new and depend for every type of machinery on outside countries could not compete with the foreign industry for a long time to come. Such were the state of affairs when the first Great World War came. During this war, the scarcity of some essential commodities was felt but as the war did not last long (4 years—1914 to 1918) its effect was not lasting. *Ghee*, *ata* (wheat flour) and milk had become dearer but the carry over of consumer goods was sufficient to off-set the scarcity caused by lack of imports. The war did not cause much economic disruption and whatever urge for land improvement appeared in the minds of the then Government, it got subsided with the termination of war and the old order continued again in full swing. This went on for about 20 years more when the second World War came. This war on the modern scale implied total mobilisation of all resources, agricultural as well as industrial, and the European countries were long prepared for a transition as soon as the need arose from peace economy to war economy but we in India were magnificently unprepared in spite of the lessons of 1914-18. This war opened the eyes of the Government and the public and everybody else and brought out the real picture in its true nakedness. It brought out the full consequences of a policy of drift, indifference and apathy on the part of the authorities for many a decade. Prices rose rapidly and there was an increasing additional strain on the transport system and India found herself face to face with food crisis in the country, probably unprecedented in her annals. It showed how much short we were of food and in which direction the agricultural economy was drifting. India's self-sufficiency had been broken. Village could not supply enough food and one of the reasons given was that population had increased and there was not enough food for the people. This may be one of the reasons but it cannot be the sole reason. The real reason for scarcity is that the country is not producing so much as it should and as it can. It depended all these years in imports and the stoppage of import and partition of the country by which a substantial amount of food material was lost to the Indian Union the scarcity became acute. It has taken nearly 200 years for the British Government to destroy the village life and hence it must take at least 20 years, if not 50 years, to reconstruct it and to bring it back to the level of self-sufficiency and prosperity as it was before. The Government of India is now importing food to the value of Rs. 1 crore 25 lakhs per annum. It is a praiseworthy attempt indeed to save the lives in this sub-continent in this manner but this process cannot go on for long without jeoperdising the economic interests of the country. The country must learn to stand on its own legs and that too as soon as possible.

The important problems that need immediate attention to develop agriculture in future, thereby gaining self-sufficiency in respect of food and other agricultural commodities are as follows:

I. BACK TO THE VILLAGE

We must produce more and one of the best ways of doing that is to revert to the old system of making individual units self-sufficient. This is not possible without improving the village in all its aspects. Life in a village is very much different nowadays from the life in the town. There is a big gap between the two. No decent educated youngman likes to go to a village and live there. We will therefore have to concentrate all our energies on improving the villages and to make them suitable for the habitation of educated youth. There should be good roads, good sanitation, good education and medical facilities, electricity etc. to make them worthwhile for the present day educated youngmen to live in.

Sir John Russell, a British Agricultural Expert and Director of the Rothemstead Experimental Station in England, who is considered to be a world authority on agriculture, while visiting India in 1937 to review the work of the Indian Council of Agricultural Research, made various recommendations for improving the agricultural conditions of the country ; and one of the most outstanding recommendations made by him was to bridge the gap between the village and the town and to make the former worthwhile for the youngmen to go and settle in. The writer had the privilege of working as his Secretary-Adviser and accompanied him in his tours throughout the country. Wherever he went, he put questions to persons at various stations engaged on problems connected with agricultural research and development and found that almost all of them came from the villages. He was thus convinced that the villages possessed all the necessary intelligence and energy required to develop the country but these needed to be harnessed properly to improve the existing conditions. Thus, one of the foremost and first essential prerequisites for planning of agricultural in the future is to reshape the village in such a way as to make it good enough for the habitation of youngmen who are at present being lured by the attractions of town life. Already healthy signs are appearing and a trend in this direction is visible in both the educated youngmen and the government; the former due to stress of life in the towns are now liking the agricultural profession and the latter by introducing urgent reforms such as abolition of the *zamindari* system and revival of *panchayat* rule are helping to improve the village life.

II. BUILDING UP OF THE IMPAIRED SOIL FERTILITY

(*a*) *By proper utilisation of dung and other indigenous resources for manurial purposes.*

India's lands have suffered very greatly on account of continued drains during the last one or two centuries on their fertility without replenishment. The chief reason has been the lack of interest of the cultivator to improve his lands due to his illiteracy, the old tenancy laws, fragmentation of holdings resulting in poor economic returns and his continued indebtedness. These factors coupled with export of bones, burning of cowdung and waste of animal and human excreta and other waste products carried over for such a long period brought about such an amount of deterioration of the land that it will take a long time before this loss can be repaired. During all this period we failed even to copy the practices of our neighbouring countries like China, Japan and Korea, who have maintained the fertility of their soils through generations by their own indigenous methods.

In China almost every foot of land is made to contribute material for food, fuel or fabric. Everything which can be made edible serves as food for man or domestic animals. Whatever cannot be eaten or worn is used for fuel. The wastes of the body, of fuel and of fabric are taken back to the field and before doing so, they are housed against waste from weather, intelligently compounded and patiently worked at for one, three or even six months, in order to bring them into the most efficient form to serve as manure for the soil or as feed for the crop. It seems to be a golden rule, with these industrious people or if not golden rule, then an inviolable one, that whenever an extra hour or day of labour can promise even a little larger return, it must be given and nothing be permitted to cancel the obligation or defer its execution.

According to King (in his book of *Farmers of Forty Centuries*) the farmer in China is supporting a much larger population than in any part of the world. In China, Korea and Japan a much smaller area than the whole of the cultivated area of America is supporting 5 times the population of America. Notwithstanding the fact that in each of these countries the soils are naturally more than ordinarily deep, inherently fertile and enduring, judicious and rational method of fertilization are everywhere practised. And not until recent years, and that too only in Japan, have mineral commercial fertilizers been used. For centuries the canals, streams and the sea have been made to contribute toward the fertilization of their cultivated fields and these contributions in the aggregate have been large. The accessible portions of their vast extent of mountain and hill lands have long been taxed to their full capacity for fuel, timber and herbage, for green manure and compost material ; and the ash of practically all the fuel and of all the timber used in the home finds its way ultimately to the fields as fertilizer.

In China enormous quantities of canal mud are applied to the fields sometimes at the rate of even 70 and more tons per acre. So, too, where there are no canals both soil and subsoil are carried into the villages and there they are, at the expense of great labour, composted with the organic refuse, then dried and pulverized and finally carried back to the fields to be used as home-made fertilizers. Manure of all kinds, human and animal, is religiously saved and applied to the fields in a manner which secures an efficiency far above the practices in the Western countries. The International Concession of the city of Shanghai as far back as 1908 sold to a Chinese contractor the privilege of entering residences and public places early in the morning of each day in the year and removing the night soil at a price of more than 31,000 dollars for 78,000 tons of waste. We expend much larger sums in throwing all this away. There is also a woeful lack of care both in the methods of preservation and use of cattle-dung in India.

The present production of cattle shed manure in the Indian Union excluding Pakistan is estimated at 120m tons dry weight. The manure prepared in the villages contains on the dry basis only 0.7-0.8% nitrogen, about 0.3% P_2O_5 and 0.6-0.7% potash. In other countries like Europe, America, Japan and China, the cattle shed manure prepared contains on the dry basis about 2-2.5% nitrogen, 0.5-0.6 P_2O_5 and 1.2-1.8% potash. This includes cattle urine also which in majority of cases is wasted in India.

A good portion of the cattle dung estimated at 40-60% is also burnt as fuel, the loss in this respect represents about 100m tons dry weight. If attempts are made to minimise this wastage of precious manure by supply of alternative fuel and encouraging tree planting in villages, it would be possible to increase the present manure production to a level of 200m tons dry weight or 400m tons fresh weight.

A comparison of production of cattle shed manure and rural compost in India and Japan, where the yields of cereals are more than double of those of India are as below:

	JAPAN	INDIA
*1. Area under cultivation	14.44m acres	200m acres
2. Total quantity of cattle-shed manure and rural compost prepared ..	62.8m tons	200m tons
3. Quantity of Farm Yard Manure per acre of cultivated area ..	4.4 tons	1 ton
4. Quantity of plant nutrients added in the form of FY Manure ..		
Nitrogen ..	52.3 lb. per acre	8 lb. per acre
P_2O_5 ..	20.4 ,,	3 ,,
K_2O ..	44.8 ,,	7 ,,

It is estimated that about 12 lb. of nitrogen is excreted per human being per year and for every pound of nitrogen there is an increase of about 7 lb. of grain. Therefore for every human being there can be an increase of roughly 12x7 lb.—84 lb. or 1 md. of grain and for the whole population of India, if properly utilised, the increase can be put to about 35 crores of mds. Similarly, each animal roughly excretes about 60 lb. of nitrogen, 30 lb. in feaces and 30 lb. in urine and the total population of the animal is

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*Figures have been taken from a note by Dr. Acharya, Compost Development Officer, Government of India.

roughly half of the human beings and if their manure can be conserved properly and utilised, there can be an increase of 5 mdsx 17 crores of animals, 85 crores of maunds. The total increase both for animals and human beings can thus be 120 crores of mds. of cereals. In addition to the above values of nitrogen which this manure would add, it would be the organic matter and phosphoric acid contents that would be still more valuable.

The general system in China and Japan is to apply liquified night soil to crops. In India a scheme was started in 1943 with the object of converting town refuse and night soil in urban areas into compost manure for sale to agriculturists. Sufficient progress has been made in the scheme and there is a good demand for this type of compost manure. The main bottleneck at present is transport. The problem of recovery of the night soil of the rural population is being tackled by introducing Wardha system of trench latrines in villages. The problem being a gigantic one, it will take a long time before appreciable success can be achieved in this direction.

(*b*) *Application of soil conservation practices to cultivated lands.*

Another method to preserve soil fertility is to resort to such farming practices as would prevent soil loss by erosion either by rain or wind. The continued existence and prosperity of most countries have depended on their ability to maintain the productiveness of their agricultural lands. It will not be possible to maintain present production, to say nothing of increasing production, if the soil is permitted to be wasted by erosion and outmoded agricultural practices.

According to Mr. Bennett, Chief Soil Conservation Officer of the United States Department of Agriculture, soil conservation does not merely consist of terracing, contouring, strip cropping, filling gullies or planting excessively steep or erodible land with grass and trees; it is that and whatever else needs to be done to keep the soil permanently productive or make it more productive. It means drainage if the land is too wet, irrigation if it is too dry and it means addition of fertilizers and organic matter if the soil is deficient in these constituents. Every day of delay in applying conservation to the land means just that much more loss of food for the people now and in future and it means also a more difficult and expensive job. There are many causes of erosion in India, the chief being the grazing by cattle. Our cattle population is far in excess of what the land can safely support. This has resulted in overgrazing of the pastures, especially in the foothills and in the forests because of the scarcity of pastures in the plains and lack of enough forage crops or straw for stall-feeding. There is a grevious lack of balance between the livestock and the available feed, and this factor brings in its wake many wrong adjustments in the use of land. An important factor that stands in the way of preventing soil losses and maintaining soil fertility is the size of the holdings. Small and scattered fields situated at distances from the village receive very little or no attention and this results in their deterioration. The wanton destruction of the forests near the habitations has also resulted in an acute fuel shortage. The villagers are obliged to use cowdung, grass, leaves and crop stubbles as fuel to cook their food, thereby depriving the soil of the main available source of manure and organic matter. In an indirect manner defective drainage and water-logged conditions also increase the erosion hazard. Erosion problems in India, particularly in the Punjab and the U.P. have so far been studied primarily from the point of view of deforestation. A beginning has however been made with cultivated lands in some places particularly in Bombay and the Punjab. In the former place construction of bunds across the slopes and in the latter 'wat bundi' built all round the field have up to so far been found to be the most useful conservation practices under Indian conditions. In the United States various conservation practices such as contour cultivation, listing, terracing, strip cropping, rotation of crops, green manuring, cover crops, crop residue management by stubble-mulch farming and fertilizer application are being extensively used to check erosion on cultivated land. Some of these methods such as green manuring, fertilizer application, rotation of crops etc. are already being adopted commonly in India. Measures to improve soil fertility and some useful work on application of conservation practices in dry regions have also been carried out in schemes run for 15 years under the auspices of the Indian Council of Agricultural Research. But the application of full conservation technique in its different phases for cultivated area as developed in America yet needs to be explored in India. The means of approach to the problem lie in two ways, *i.e.* (1) publicity and propaganda and (2) demonstration. The first will involve use of upto date methods to impress upon the farmers the desirability of following well-proved conservation practices and the second will bear fruitful results only after some years as it involves trials in different areas of various conservation practices which have proved successful in improving soil productivity and also experimentation with the methods which have proved successful in foreign countries. It is also necessary that there should be close cooperation between the Departments of Forests, Agriculture and Irrigation, both at the Centre and in the provinces, for initiating and developing different phases of the conservation programmes.

(c) *Mixed farming*

Another practice which is extremely useful for maintaining the fertility of the soil is that of mixed farming. The Indian Council of Agricultural Research sanctioned a few schemes to find out the value of mixed farming in different areas and the results obtained under these schemes invariably showed that mixed farming was better than ordinary farming without milch cattle. The advantages of this type of farming are obvious. The cattle produce a large quantity of farm yard manure which can be added to the soil, thereby increasing its fertility resulting in increased crop production. This enables more areas to be released for raising fodder crops and legumes which besides providing fodder for the cattle increase the soil fertility directly by virtue of their capacity to fix the atmospheric nitrogen. Mixed farming makes the farmer more independent of the outside help for manures, economically sound and healthy. The condition of cattle generally serves as an index of his economic condition. If his cattle are poor and emaciated, it can be taken for granted that his land is not being used properly, he is not making good profits and his general condition is unsatisfactory but if his cattle are healthy and well-fed his land would be more fertile, his economic condition would be better and he and his children more healthy. The cultivators generally keep their cattle on maintenance ration. This is a wrong conception as whatever the cattle consume they return with other manifold advantages.

III. MECHANICAL CULTIVATION

Generally great stress is laid on the supply of water and manure to the land and it is considered that if these two things are provided, the results will be good. But another most important thing which needs just as much attention as any other factor is the proper working of the land and good preparation of the seed bed. For this purpose two things are essential—one, labour and the other, suitable implements. Due to the scarcity of labour and the high wages, the time has come when greater use of mechanised appliances should be introduced. In the new set-up when the *zamindary* system is being abolished and the labour is asserting its equality with other better classes of people, the application of labour-saving devices has become imperative. Estimates of land area for the year 1940-41 for the undivided India and the States show that the country had 100,00,00,000 acres of land at its disposal as under:

	Acres	Acres
1. Land under forests	107,000,000	388,000,000
2. Land not available for cultivation	281,000,000	
3. Cultivable wasteland	171,000,000	612,000,000
4. Current fallow	79,000,000	
5. Cultivated land	362,000,000	
		100,00,00,000

With the heavy pressure of population on land as it is at present, India can ill afford to allow a large area (estimated to be 250m acres consisting of 170m acres of cultivable waste and 80m acres of current fallow) to remain unutilised. Lands infested with deep rooted weeds (*kans* and *hariali*) and under waterlogged conditions will have to be reclaimed. The Central and provincial Governments are already importing heavy machinery for reclaiming such areas. The Government of India are running a Central Tractor Organisation for supply of tractors and other heavy machinery to different provinces for this purpose and sufficient progress has already been made in this direction in different areas. But these heavy tractors are mostly useful for ploughing large areas of fallow lands and deep ploughing of weed-infested tracts. They require large initial outlay, costly operators and, as working period will be generally short, they have to be kept idle for the greater part of the year, thereby adding to the overhead charges. For cultivated areas of which there are about 362m acres in the country (undivided India) and where deep ploughing is unnecessary and may even do positive harm, a smaller machinery capable of being used by general farmers will be more popular.

The conditions in India are very much different from those in America and Western countries. Here the tropical sun, the teeming population, the tiny holdings of the average cultivators, the concentration of rainfall to a limited part of the year with its practical absence for the rest of the period; the long period the lands have been under cultivation without sufficient manure necessary for their recoupment; and the absence of machine-mindedness on the part of the agricultural population—all these factors present problems different from those of the Western industrial countries. Any power-operated machinery that is introduced into this country for working large cultivated areas has, therefore, to take into account the peculiar conditions referred to above and the machinery has to be specially designed to suit those conditions. Except in irrigated lands which form but a fraction of the total area under cultivation, the crops have to be grown and matured only in the rainy season when the land will be soft enough for tilling and the ground will have retained sufficient moisture to bring the crops to maturity. It is necessary that all land should be tilled and seeds sown within a week or ten days after the first monsoon rains. This need is well understood throughout India as it is generally seen in every agricultural village that as soon as there is a heavy shower of rain, every ryot is on his field ploughing the land. It is in order tc have this simultaneous ploughing that every agriculturist maintains a sufficient number of plough cattle so that he can have his lands ploughed and seeds sown within a week or 10 days after the first rains. Any machine that will come into general use in this country should therefore satisfy this fundamental condition. Secondly in the absence of roads or trackway to the fields, the plough should be light enough or the heavy parts readily detachable so as to be capable of being carried by a few men to the field and assembled in a few minutes for use. Thirdly, the cost should be such that a small cultivator having about 15-20 acres or a small group of cultivators of a like area can afford to get a mechanical plough and till the whole of their 15-20 acres within a period of 10 days. The machine should have the capacity to till about 1½ acres a day of say 8-10 hours of working. The total cost should be near about Rs. 1,000. This machine should not be complicated but should be easy to manipulate and should have all spare parts readily available. The power unit should be detachable or made available for use for other work such as pumping, cottage industries and garden cultivation, etc. when the plough is not in use. The frame and wheels may, if necessary, be of timber strengthened by steel plates so that the machine can be made cheaply and repairs can be effected by country carpenters and smiths. If Indian engineers set to work to design a unit to satisfy the above conditions, it can easily be accomplished. Such a machine will soon become very popular and come into extensive use in a short time especially now when plough-cattle are very costly and in short supply. An agriculturist cultivating 15-20 acres requires at present about 2-3 pairs of cattle which, at present day costs, cannot be obtained for less than Rs. 1,000 even for average-sized animals. The agriculturist will not therefore grudge to invest a little more in securing a reliable mechanical plough.

The better tillage and timely work attained by the use of the machine will enable the cultivator to get a greater yield from his lands and will go a long way towards securing to the country's self-sufficiency in food production. The educative value of such machinery to the agriculturist, the impetus the machine will give to the educated classes to take to productive labour instead of looking on to clerical work as their sole aim and the secondary lucrative occupation which this will give to the agriculturist will all raise the standard of living in the villages and tend to put a stop to the migration of villagers to towns and even promote a tendency in the opposite direction

IV. DEVELOPMENT OF THE RAIN-FED (*BARANI*) AREA

The first and foremost requirement of the farmer is the regulated supply of irrigation water. The Government at present is tackling this question of irrigation under two categories, i.e. one by sanctioning big projects of bunding river valleys such as the Bhakra and the Nangal in the Punjab, the Damodar in Bihar, the Hirakund in Orissa and the Tungabhadra in Madras, etc. but as these projects will take some time to mature and there is urgent necessity to increase the production of crops, the water resources are being increased wherever possible by the other method of excavation of new and repair of old wells, tanks and reservoirs, repairing rivulets and streams and nullahs.

These are intended to supply water immediately during the period till the main projects are ready. At present there are about 30m acres under anal irrigation, 30m acres irrigated by wells and 6m acres from tanks making a total of 66m acres. Altogether about 4|5 of the total cultivated area in the country is dependent purely on rainfall which is ordinarily precarious and badly distributed. To grow crops successfully on this area there is no way for India but to take recourse to dry farming methods. We should be able to reclaim or develop the dry land through understanding the principles of water conservation and acting according to them and thus making most of the water bestowed on us by nature through dew, rain and snow, etc. in growing our crops successfully.

In America, both Canada and the U.S.A., by continued research and experimental work carried out with great expenditure, labour and energy, they have evolved practical methods that have made farming quite safe in the areas receiving 10 inches annual average rainfall. And there are instances, in specially dry years when there was 46 inches rainfall, fairly good crops of wheat were taken. In Canada at a farm in Saskatchewan with the average annual rainfall of about 7 inches a yield of 28 bushel (22.4 md.) of wheat per acre was obtained, while in 1894, which was the driest on record in a period of 20 years with rainfall of only 3.90 inches, 17 bushels of wheat were raised per acre in comparison with the highest yield of 49 bushels, a bumper crop, obtained in 1901 when the rainfall was 20.22 inches, the best year of the period. The rainfall was 1|5 while the yield was 1|3 compared with those of the years recorded. Very encouraging results have also been achieved in Bombay Presidency where by application of dry farming methods in Sholapur, they got from 1.5 to 5.9 times over and above the yield obtained by the local cultivators' methods. Within the next decade we can double the produce through dry farming methods, which is quite possible, as the scope and potentialities of dry farming is stupendous, looking at the areas involved, over 300,000,000 acres i.e. half of the total cultivated area (of undivided India). But unfortunately we are not giving due importance to these methods and are trying to solve the food problem only by concentrating on development by means of big irrigation projects, mechanization of farming with heavy tractors and intensive cultivation.

Dry farming methods, unlike the big projects, do not require heavy outlay. It is simply to understand the principles of nature and moulding our practices according to them. But the difficulties in these methods also are many. Not only thousands but millions of the cultivators of the arid regions are to be enlightened. We are a great nation and fortunately at present free to do as we like. With a capable and a very active person having full knowledge of dry farming at the centre and about a dozen such persons in the various provinces with as many experimental farms at suitable places and some demonstration farms run by educated and interested persons, encouraged and financed by the State to take up the work, the whole situation can be changed in a short period, say five to ten years, and the land can be made to grow not only 40,00,000 tons but 400,00,000 tons more food.

A dry farmer in America with the help of modern implements and four horses cultivates and gets good crops of wheat on 200 acres of land, while the dry farmer here cannot farm efficiently even one-tenth of it. The practice of dry farming however requires more intelligence, more implicit obedience to natural laws and greater vigilance than farming in regions of abundant rainfall. A good deal of research work on different lines have already been carried out in the dry farming schemes sanctioned by the Indian Council of Agricultural Research in the past and a monograph has also been published on the results achieved in these schemes. Steps should be taken to apply the knowledge already achieved in different regions and researches should be conducted on such problems as need further investigations.

V. ERADICATION OF WEEDS

Loss due to weeds, though generally recognised, is far greater than usually realised. It has been estimated in the U.S.A. that weeds cause more than double the combined loss caused by insect pests and diseases. The U.S.A. Chamber of Commerce listed 30 items of waste in the U.S.A. farm of which weed problems were second only to soil erosion. It was estimated that before World War I, about 16.5m pounds sterling per annum were lost by farmers in Great Britain in removing weeds. An overall picture of the loss incurred directly or indirectly on account of weeds in India is absent. However, the few scattered information available about our crop-weed relationship gives some idea about the magnitude of the weed problem in Indian crop husbandry. The *kans* weed (*Saccharum spontaneum*) has laid waste millions of acres of valuable land in the C.P. the U.P., Madhaya Bharat, Vindhya Pradesh, etc. causing an annual loss of crores of rupees for the last so many years. Similarly wild rice is a serious menace to rice cultivation, particularly in the C. P., Bihar and Bombay. It causes loss over 37 lakhs of acres of Biasi paddy in Chhattisgarh division (C.P.) alone amounting to the tune of more than Rs. 22 lakhs annually. The nut grass (*Cyperus rotundus*) which is a troublesome weed of the tropics and sub-tropics is a particularly pernicious weed in India growing in all types of soils all over the country with unusual adaptations for tiding over long dry spells of the year. *Hariali* (*Cynodon dactylon*) infects all types of soils equally severely Similarly *baru* (*Sorghum halpense*), prickly pear (*Opuntia*), *gokhru* (*Xanthium stumarium*), etc. are also noxious weeds invading crop lands to lay them to waste and make them unfit for cropping. In Bengal deep-water paddy worth some Rs. 11 crores is supposed to be destroyed annually due to the depradation of the water hyacinth (*Eichornia crassipes*).—(*Basak* Meghnath—*Water Hyacinth Compost Government of West Bengal,* 1948). Among the parasitic weeds, broom rapes (*Orobanche crenua*) has been found to cause serious damage to tobacco crop which in Guntur District (Madras) alone, in 1940, has been estimated to be about Rs. 36 lakhs and in Bombay nearly Rs. 10 lakhs (Kumar—*Indian Farming,* 1942). Similarly other parasitic weeds like striga on sugarcane and millets, Balanophora on coffee, dodder on clovers, Loranthus and Viscium on horticultural crops cause considerable havoc in several parts of India, the estimation of which is difficult. They spoil land and reduce the value of the crops and live-stock products and in manifold ways are source of great nuisance to man and his affairs.

Weeds absorb from the soil and transpire large quantities of water. On investigations of the water requirements of some of the typical weeds which infect arable land at Dry Farming Research Station, Sholapur, during 1941-42, the transpiration coefficients at the flowering stage were found to be 556 for *kunda* (*Ischæmon pilosum*), 813 for *hariali* (*Cynodon dactylon*), 1108 for *Tephrosia purpurea* and 1402 for *Tridex procumbens,* while it was only 430 for the typical *jowar* crop. These co-efficients indicate the high water requirements of the weed as compared with those of the cultivated crops. Nijhawan (*Indian Farming,* 1944, pages 58-60) showed that it was possible to save 300 to 500 tons of water in an acre of soil to 6 feet depth by keeping it free of weeds under the dry farming conditions at the Dry Farming Research Station, Rohtak. His later work showed that fallow plots clear of weeds contained 532 tons more water in a six feet column of soil per acre than weeded plots and this quantity of water could produce about 1600 lb. of dry matter of *bajra.* Such huge loss of moisture equivalent to about 5 inches of irrigation and capable of raising 20 maunds of crop can be saved if the land is kept free from weeds. Weeds are harmful in this manner, more so particularly in the hot season in arid regions and in areas of precarious and uncertain rainfall, and the harmful competition is most felt by cultivated crops on light sandy soils.

As regards their demands on mineral nutrients, according to Crowther (*Empire Journal of Experimental Agriculture,* 1946) in Sudan (Geizara) cutting of unripe weeds in cotton at ground level, while they were still growing, conserved moisture till the rains, increased soil nutrients five-folds and led to an increase in the yield of cotton crop by 43% over the normal practice. In India at a conservative estimate the reduction in the yield of cotton caused by *kans* is at least a third of the crop, as stated by Howard (*Agricultural Journal of India,* 1927. page 12). The loss in rice caused by wild rices is 5-30% in the C. P. and Bombay (Salimath in *Agriculture and Livestock in India,* 1937, pages 479-92) and the general crop yield is about 50% due to nut grass (*Cyperus rotundus*) as stated by Pillay (*Indian Farming* 1944—pages 67-68) and is 30% by weeds as a whole as estimated by Luthra (*Punjab Weeds and their Control,* Govt. Press, Lahore, 1938). Weeds also deteriorate the quality of crops by mixing with them. Want of proper cleaning and preparation of crop produce have been underlined in the numerous agricultural marketing reports as the prime causes for the low price Indian crop products fetch in internal and international markets. Advanced agricultural countries have seed testing and cleaning stations, practices and laws regulating the sale of crop seeds and controlling the sale of those containing undesirable weed seeds. India has still to fall in line with such progressive countries for producing weed-clean seeds. Sir R. N. Chopra in *Indian Journal of Agricultural Science* (1940) pages 1-44, describes some 700 poisonous plants in India, a large number of which are weeds, some of which cause considerable injury and some times even death to men and cattle. Kehar (*Indian Farming* 1943, pages 130-31) states that cyanogenetic glucoside is widely distributed in many plants and HCN is found in 148 species of plants belonging to 41 families. Though some of these plants are protected by unpleasant odours, bitter tastes or by spines, etc. the poisoning of animals by such plants are a common occurance in India in spite of the widespread belief that they are protected by some instinct from eating dangerous plants. The annual loss in the U.S.A. due to cattle poisoning is estimated to be over 200 million dollars. Similar losses are noted also in U.K., South Africa, Australia and Germany. In India, where the fodder problem is acute, pasture land policy absent, the natural pastures are over grazed, the limitedly available public grazing grounds infested with numerous poisonous weeds, with the largest cattle population of the world to maintain, the loss due to plant poisoning of cattle will be nothing short of phenomenal. According to Venkatachalam (*Indian Farming* 1943—pages 57-75) the loss incurred annually through poisonous plants in drop in milk yield loss of meat and wool, abortion and sterility, temporary or permanent, injuries to the various organs of the body may exceed 20% of the value of the total livestock of India or nearly Rs. 400 crores. There are two methods of approach to the weed problem, either to keep weeds under such control that their harmfulness is restricted or limited or to work out their outright eradication. Timely and adequate tillage, weed-free seed, good rotation and crop sequence, and quarantine against weed-contaminated imported seeds and feeds should be the chief reliance against weed infection. In the main, every thing that contributes to better farming, constitutes in some degree to weed control. Quite recently harmone weed killers have revolutionised the very problem of the herbicidal control of weeds; some of them (like 2.4 D.-cholorophenoxyacetic acid, etc.) are found to have selective action against Dicotyledonous weeds only, while others (like N:N-D carbo-ethoxyaniline, Isopropylphenylcarbonate, etc.) seem to have the opposite effect being selectively lethal to Monocotyledonous plants, (as indicated by Pearse in *Growth Promoting Substances and their Practical Importance in Horticulture.* CAB Technical Communications No: 20, 1948, pages 71-72). This seems to open up a vast vista of future possibilities in discriminative control of weeds whether it be Dicotyledons or Monocotyledons by the judicious application of the suitable harmones alone. However, this does not indicate that the weed problem as it exists in India can be solved by chemical eradication, much less by these new weed killers only, as the trial on these should be conducted under conditions experienced locally, since weeds vary greatly in their virulence and aggression in different soil-climatic conditions, in relation to different crops. The Indian Council of Agricultural Research has sanctioned schemes for investigations into the chemical aspect of weed extermination at 3 or 4 centres such as Bose Research Institute, Calcutta, Botanical Laboratory, Kanpur, and IARI, New Delhi. The Bose Institute is also investigating the possibility of manufacturing indigenous chemicals locally. About half a dozen important local weeds would first be tried with the chemicals which are commonly used for killing these weeds in other countries. The work, if found successful would be extended to other provinces. The problem needs to be tackled in a coordinated manner with utmost speed to save the tremendous loss caused by weeds to agricultural crops.

VI. CONTROL OF PESTS AND DISEASES

A considerable loss is caused by insect pests both to the field crops and stored grains. The following resolution of the F.A.O. Council passed in this connection in 1948 is noteworthy:

> "The Council directs the most emphatic attention to the problem of loss of food by infestation, disease and all other forms of waste. That preventable loss of food on the scale that has been estimated should occur at any time is lamentable enough, but that it should take place under present conditions of shortage is, in the opinion of the Council, perhaps the most deplorable feature in the whole picture of the current food situation. No effort should be spared to lessen waste in all its forms; nothing is likely to bring a quicker return."

The importance of crop protection was also stressed by the Bengal Famine Enquiry Commission who considered the low yield of paddy crop due to a single disease to be one of the basic causes of the Bengal Famine of 1943. The Commission recommended that the Centre and all the provinces should immediately establish plant protection services. Consequently the Directors of Agriculture and Plant Protection Officers of the various provinces and States met in New Delhi in June 1949 and decided upon measures for intensifying work on pests and disease control. It is estimated that about Rs. 500 crores worth of agricultural crops are lost in India due to damage caused by insect pests and plant diseases and also due to damage to grains during storage. Of this about half is on account of losses to food crops. This problem should be tackled energetically and with modern methods of crop protection and storage of grains, and it should be possible to prevent this colossal waste, which is sabotaging the Grow More Food Campaign. Adequate supplies of all pesticides are available and supplies of spraying and dusting machinery are not difficult to obtain at short notice. What is required is an extended staff both at the Centre and in the provinces and States to ensure that adequate and timely use is made of those materials which are useful in combating pests, fungi and all the other lesser known diseases which attack all kinds of food crops. Researches should also be undertaken on the manufacture and use of cheap insecticides, fungicides, etc. by using indigenous material. The most serious disease caused to any one single crop is that of the rust on wheat. The damage in certain areas is so extensive that even enough seed is not left during some years for sowing. Intensive work has been conducted in this respect for over 20 years in the country under the auspices of the ICAR and very useful information of the causes of disease and the probable methods which should be adopted to eradicate it have been indicated. It is said that the only effective method of controlling this disease is to produce the disease-resistent varieties of the crop. For this purpose a scheme has been in progress in Simla for over a dozen years and the work has reached a stage where varieties that are resistent to individual rusts separately have been evolved and these are being crossed to produce a variety that will be resistent to all the three rusts simultaneously. Some strains of this multiple cross have reached fourth and fifth generations, and it is expected that very soon desirable type will be made available for distribution for trial purposes in different areas. If this work proves to be successful, this will be the first of its kind as so far no single variety has been produced which is resistent to all the three rusts together. The Government of India have quite recently sanctioned a co-ordinated scheme for intensifying mycological and botanical work on this most serious disease in the country. As far as State action is concerned, legislation has been passed in India embodying two lines of defence against insect pests and fungous diseases. The first one prevents the entry of foreign insects into the country while the second seeks to eradicate them. The Plant Protection Directorate of the Government of India is given charge of this work and the Storage Directorate of the Food Ministry is tackling storage problems under different climatic conditions. As the appearence of diseases and insect pests is intimately correlated with the elevation and weather conditions of the locality, the whole problem also requires to be intensively studied, taking into account the bearing of these aspects on this problem. A crop weather scheme has been sanctioned by the Indian Council of Agricultural Research and a large number of observatories have been established in different parts of the country to corelate crop production and the appearence of the diseases and pests with the weather conditions. But as has been indicated above, the amount of damage caused by insect pests and diseases is so large that immediate attention to check this loss with the help of plant protection services in different provinces and States is urgently called for. Prevention of this loss alone can make India more than self-sufficient in respect of food and can go a long way in increasing the crop yields in the country.

VII. BREEDING FOR QUALITY

In future breeding programmes, emphasis should be laid on nutritive values of different varieties. This aspect is very important and should be paid greater attention to in future work. In wheat a scheme was sanctioned to investigate the milling and nutritive quality of wheat at Lyallpur with a view to ascertain the protein contents and vitamin contents in different varieties and the extent to which the nutritive value of wheat can be imporved upon by crossing highly nutritive types without reducing their palatability. Some results of practical value were achieved at Lyallpur but since that laboratory has gone over to Pakistan, a new scheme for the Eastern Punjab is under consideration as this is the most important wheat growing area of the Indian Union. In pulses and millets, protein content in some types was investigated in the co-ordinated pulse and millet scheme in progress under the auspices of the Indian Council of Agricultural Research. In the C.P. for example, the white-seeded gram was found to contain higher percentage of protein (23%) as compared to gold-seeded (21%) and the brown seeded varieties (16-17%). Further work in this direction is immediately called for as pulses and millets form an important part of the Indian dietary.

In rice, a scheme of research on quality in crops was sanctioned by the Indian Council of Agricultural Research in the past. It was found that parboiling invariably improves the milling quality of raw rice. Parboiled rice loses less of soluble matter on cooking than raw rice in so far as very little matter is removed with its *kanji* (drained-off liquid) as compared to the *kanji* from raw rice. The proteins are found to have diffused into the deeper layers of the endosperm in parboiled rice. Parboiled rice does not lose so much of the proteins on milling and polishing as raw rice. The presence of the amino-acid, tryptophane, in the proteins of the aleurone layer in rice makes rice a good body-building food, provided it is not lost in polishing. Polished rice is deficient from the nutritive point of view and we should concentrate on measures for pounding of rice by which we can get better nutritive rice and more of it.

Much of the protein and mineral constituents of the rice grain is located in the external layers, namely, the bran and embryo. Ramiah and Mudaliar working at Coimbatore have established that coarse grains have thicker bran layer than fine grains and the thicker the bran layer the more nutritious is the grain. Quality investigations carried out by Sreenivasan at Bangalore have shown that coloured and coarse rices generally contain larger amount of protein and mineral matter. Such varieties also require greater amount of polishing than finer rices for producing white grain. Under ordinary conditions of milling the extent of loss of essential constituents from coloured or coarse varieties is therefore less than in the finer varieties. Recent work of Hinton in England has established that the greatest concentration of vitamin (thiamin) in the rice grain is in the scutellum, the tissue surrounding the embryo and hence in breeding for nutritional quality in rice, attention should be paid to both the bran layer and the scutellum. Ordinarily, there is 7-10% of protein content in the rice grain in India. Bigger coarse red rice contains 10% protein but it is claimed that certain varieties contain as much as 13-16% of protein. It is extremely important to produce rices of higher nutritive value for eating by the large number of poorer classes who cannot afford to add other protein food in the form of pulse or fish and subsist on rice alone. The studies should be carried out at the Central Rice Research Institute, Cuttack.

As regards effect of manures on the quality of rice crop, there is some evidence to show that the nutritive value of rice is influenced by the kind of soil and application of fertilizers. Rice grown on good soil contained higher percentage of soluable carbohydrates than rice grown on poor soil; the addition of nitrogen to a deflocculated silt-loam increased the percentage of protein in rice and the iron content in the earhead and straw was greater when the crop was grown on soil possessing high soluable iron in the ferrous state. The thickness of the aleuron layer is favourably influenced by manuring with green leaf. These few results point to the need for further research in this promising line.

VIII. EXTENSION SERVICE

A large number of experiments has been carried out in different provinces on manurial, varietal and agronomic aspects of different crops and sufficient information has been gathered in these respects in the past but despite this accumulation of knowledge only a few recommendations of the provincial Departments of Agriculture have so far been adopted by the general body of cultivators. Speaking generally, the crops grow well on Government farms wherever situated but little improvement is visible even in the fields of cultivators adjoining these farms. The question of translating the results of research into general practice has been engaging the attention of the Indian Council of Agricultural Research for a long time and they have been inviting experts periodically to review the work of the Council and to suggest ways of effecting improvements in future. Sir John Russell, who reviewed the work of the Council in 1937, emphasised in his report the need of carrying out simple experiments on cultivators' holdings to bridge the gap between the experimental stations and the cultivators fields. But unfortunately the position has remained very much the same and there has been little improvement in introducing improved practices in the cultivators fields. In 1947 Dr. Stewart examined the work and made suggestions for the planning and conduct of future experiments. According to him, failure to achieve, under ordinary agricultural practices, large scale reproduction of the high yields of many Government farms is due to two main causes, viz.

(1) The soils of India have been undergoing progressive impoverishment over a long period and, because of his own poverty, the cultivator cannot afford the cash outlays which are involved even in relatively small scale improvement measures.

(2) There is a lack of sound information on what exactly is needed to overcome the poverty of the soils under the widely differing conditions obtaining throughout India.

The first of these has widespread social and administrative implications and requires the attention of various departments. The second requires more careful and detailed work to elucidate the effects of various factors which have made individual, aggregate and cumulative contribution to the high productivity of Government farms. The present knowledge of the effects of individual nutrient supplements under different soil and climatic conditions is inadequate. To investigate this fully, consideration should be given in the planning and conduct of future work to two main types of experimentation:

(*a*) Simple experiments in fields of cultivators to test the most promising results of past work,

(*b*) Research and detailed experimental work at carefully selected centres supplementary to existing Government farms.

Dr. Stewart suggests that the scope of the crop-cutting survey organisation should be enlarged to include simple experiments in cultivators fields. He considers that there will be no better means of obtaining quickly and cheaply the much needed information on manuring and other aspects of agricultural improvement in India. As however the staff and the money cannot be obtained all at once, a modest beginning may be made with one district in each province. The number of experiments per crop per annum in each district should be about 30 spread out in different villages. He strongly recommends the carrying out of soil analysis of the areas where these experiments are carried out with a view to be able to correlate the soil data with the crop growth in order to find out the reasons of negative and positive results of application of different manures. This work has been neglected in India in the past and should be carried out in the manurial trials in future.

In the United States, the Extension Service is an educational agency run by the co-operation of the Federal and State Governments. Its main function is to educate (1) the farmers in better farming methods, (2) the farmer's wife in better cooking and house-keeping methods and (3) the farmer's children in better recreation, health and hygiene.

The Service operates through a number of District and County Agents working under the control and supervision of State Directors of Extension Service. The nerve centre of these activities is the State Agricultural College, where the State Director is located and works with his Assistants and Advisers. The County Agents and their Assistants are in close contact with the farmers and their organisations.

They carry the result of researches and better farming methods to the farmers on their fields by actual demonstration and also help to solve the problems of the farmers with the assistance of Experts. The 48 States constituting the United States are divided for administration purposes into 3107 counties. The total number of extension workers employed in this service in 1948 was 11,440 as against a number of nearly 1,500 when the service was started initially in 1915. The total expenditure on the work during the fiscal year ending on June 30, 1947 was 53 million dollars, which is equivalent to Rs. 17.7 crores. Nearly half of this expenditure is borne by the Federal Government and the other half by the State Governments, County Administration and the farmers, organisations. The main distinguishing feature of the extension service is the field demonstration carried on through voluntary local leaders. The Extension Service man is only a friend and a guide to the farmer to whom he brings information about the latest improvement practices and whose problems he carries to the higher quarters for being tackled. In India the question is more complex because of the wide gap existing between the research station and the cultivators fields and the poor economic conditions of the cultivators. The demonstrations of the type adopted in America have been carried on for a long time in India without much result. The solution seems to lie in the directions pointed out by Dr. Stewart. The Ministry of Agriculture has appointed a small committee of experts to go into this question and to suggest a model plan suitable for Indian conditions, which may be adopted in different provinces and States after such modifications as may be found necessary by the Governments concerned. The committee have prepared the broad outline of a plan which is receiving consideration of the Government.

IX. STAFF AND GENERAL

A. For research it is extremely important that persons who have been found suitable for particular jobs should be retained permanently on these posts and not shifted. At present it often happens that research workers are transferred from one post to another thereby all the experience gained by them in a particular branch of science is lost both to them and the country. In England, America and other European countries research workers remain on their posts permanently and would get all the emoluments and other benefits which they would get by shifting to other administrative jobs. There is thus no attraction left for them to seek another post carrying a better salary. In this way the scientists become specialists in their own lines in course of time. Similar measures should be adopted in India also where research talent is available in abundance but is often wasted by continued shifting of workers from one job to another.

B. For development and posts of directions only sound agriculturists with long experience of practical work in the field should be appointed. It often happens that in the agricultural service people are appointed to responsible positions who have never studied the science of agriculture in their career. This defect needs to be rectified. Like doctors and engineers, who cannot become proficient in their respective branches of profession unless they have mastered their sciences after long practical experience, agriculturists also cannot develop proper capacities for direction and initiative till they have acquired sound knowledge of the field work. Laymen often consider that agriculture is an easy subject and consists only of ploughing the land and raising the crops but actually the things are not so easy as they look. It is the proper understanding of balanced application of various factors pertaining to different sciences such as chemistry, botany, mycology, entomology, animal husbandry, engineering, forestry, statistics, meteorology, etc. in relation to crops, that makes one a proper agriculturist and this is acquired only after sound agricultural training and grapling with the cultivators problems for a long time.

C. Another point of general interest to which I finally wish to draw attention is our weakness for flare of the West. As a result of our subjugation for nearly 150 years we have developed a sense of inferiority complex and looking upon everything European and American, be it workers themselves or their literature, as a hall-mark of efficiency. This is a wrong conception and we should try to get rid of it as early as possible, as it is causing a lot of harm to the development of initiative and drive in the minds of our young workers. If an estimate is made of the results of our various experts and deputations to outside countries and of outside experts to our country, the sum total of the effect on cultivators fields, so far as agriculture is concerned, would be found to be very little. I do not mean to say that contact with the outside world and scientists of other countries should be stopped altogether or we should cease to adopt their methods which suit our conditions but what I want to stress is this that merits of our own workers who may be doing more useful work in their own humble way should also be recognised and appreciated. We often proudly give references of the foreign workers and their investigations in our writings and talks to impress on others the importance of our researches, but we fail to take note of investigations of greater practical utility which may be available at our next door. Future development can only be possible as a result of initiative and zeal brought from within and not from outside. The conditions in India being altogether different from the Western countries we cannot succeed in our mission by simply copying outside methods. We will have to evolve our own ways and means of effecting improvements by studying closely our own local problems and encouraging our local talent of which there is no dearth.

37th INDIAN SCIENCE CONGRESS, POONA, 1950

SECTION OF PHYSIOLOGY

PRESIDENT: SHRI KALIDAS MITRA, M.B., D.P.H., D.T.M. & H., F.N.I.

Presidential Address

PHYSIOLOGY OF HEALTH AND PHYSICAL FITNESS

I am extremely grateful to the Physiology (Sectional) Committee of the Indian Science Congress for the honour done to me. I very fondly hope that my colleagues engaged in public health work would reciprocate this kindly gesture by joining the annual meeting of the Congress in ever increasing numbers. Their participation would certainly enrich the discussion of this section and, such joint deliberations may lead to a better understanding of the human organism and his potentialities.

PLEA FOR A NEWER OUTLOOK

The fact cannot be denied that from the middle of the nineteenth century onwards there has been an unprecedented efflorescence of knowledge in the realms of physiology, medicine and other sciences related to the well being of man and his environment. It may be somewhat paradoxical, that in an era of exuberance of research there should be any cause for complaints. But wants are often acutely felt in the midst of plenty. Quite a few of my learned predecessors in this chair have in their presidential addresses stressed on the need for an orientation in the existing methods of teaching and research in the subject. The need for a changed outlook has been advocated by physiologists in other countries also. Sustaining moral strength from the precedents quoted above I feel emboldened to dwell on one of the essential gaps in the knowledge of human physiology. The particular lacuna, I contemplate referring to, in our knowledge of human physiology, should be viewed with great concern in the interest of the science itself and in its possible applications to the betterment of life and living of the human race.

In the flush of our knowledge on the conquest of environments coupled with our ever-growing enthusiasm for social ventures the terms 'buoyant health' 'positive health' 'optimum physical fitness' and similar expressions have not only been coined within the recent years but freely used in scientific literature. The concept of all these states of the human organism, however, are still nebulous and hazy to say the least. One has off and on heard of A1, or C3 levels of health referred to by qualified doctors and health minded non-medical persons, but I must confess that in retrospect I have failed to visualise such standards or categories of health.

Here a very pertinent question may be asked whether a study of the different phenomena which create and maintain health fall within the domain of Physiology. The answer need not be a laboured one. The opening paragraph of a well known textbook [1] on the subject reads that physiology 'signifies the study of the phenomena presented by living organisms, the classification of this phenomena, and the recognition of their sequence and relative significance, the allocation of every function to its appropriate organ, and the study of the conditions which determine each function'. According to this definition studies on health and physical fitness which is none other than investigation, appreciation and proper appraisal of the phenomena which determine the physique, organic efficiency, and motor as well as sensory fitness of human subjects fall within the domain of physiology. But the fact can hardly be denied that in the development of knowledge on human physiology from the early days when the studies veered round the phenomena of circulation and activity of frog's muscle, to the present day researches, there has been very little evidence in the studies of a definite bias on health and fitness. To put it bluntly, scant attention has been paid to integrate the phenomena associated with optimum physiological conditions of the human body as a whole.

PHENOMENA OF HEALTH—A NATIONAL ISSUE

In the present day struggle for survival detailed knowledge of the different phenomena associated with the optimum state of 'health' or physical fitness has assumed the importance of a national issue. It must however be understood, that by making a specific reference to physical fitness the importance of emotional, intellectual or social fitnesses are not underrated. But the phenomena determining mental health have been kept outside the purview of this address for reasons more than one. Though the precise relation of health to physical fitness and vice-versa has not been established it would not be wrong, in the present state of our knowledge, to presume that health and physical fitness often go together. No state can maintain its independence, integrity, or its very existence, unless it can ensure the supply of efficient man power to its industries, agriculture, and last though not the least to its defence services. Consequently the importance of the study of the physiology of health, has transcended the limits of purely academic interest or dream of social workers.

There is yet another utilitarian aspect of this problem which has become increasingly evident in most of the countries of the East, and also in some of the war ravaged territories of Europe. The people in these countries have suffered intense privations through shortage of food and housing during the last six, seven or eight years. The concurrent rise in prices all over the world has reduced the purchasing power of the people, thus bringing in its trail an appreciable incidence of lowered state of health, popularly described as mal—or under-nutrition. A big problem which is facing the administrators of health organisation in such countries is one of determining health standards by suitable yardsticks. In matters of relief and rehabilitation the medical advisers to Governments have often to assess whether one group of people are in a lowered state of health or nutrition as compared to the other groups. Such information is essential in the matter of determining the size of the rationed foodstuff, distribution of milk and other supplementary foods, allocation of housing and other measures for relief.

One can easily imagine the embarrassment of a public health officer who was once asked by a senior administrative official of the then Government of undivided Bengal in 1944, soon after the Famine, to report within a few days which of the districts or subdivisions in the province needed more relief than others, and to grade the regions in descending order of nutritional status of their residents. This problem was presumably no different from the one which some of the health experts in Allied Control Commission in Germany and elsewhere in 1946-47 were faced with, in deciding the size of ration and priorities for different areas and groups of people. In regions devastated by wars or suffering from economic disruptions consequent to having been militarily occupied by foreign belligerants, mobilisation of limited food resources and judicious distribution thereof on a physiological basis were problems of serious magnitude. Such problems have cropped up in the past and are very likely to recur unless the food problems in the world are fully solved. The chances of such an event taking place in the immediate future are however very remote. A comparative study of vital indexes may be of some value in long term disease surveys but not in the circumstances referred to.

The situation would have been different if so called signs of nutritional deficiency could to any appreciable extent be relied upon to assess the state of lowered health or nutrition. Experience of nutrition workers in India[2] and the reports [3-7] from the various prisoner-of-war camps and finally the observations of Adcock *et al*[8] have definitely established that the percentage incidence of nutritional stigmata such as phrynoderma, xerosis, Bitot's spots, dryness of the skin, angular stomatitis, glossitis, scrotal dermatitis or cheilitis in any group of people could not *per se* indicate the over-all state of health or nutrition of that group. Large number of people even after losing appreciable percentage of their weight did not exhibit these signs; whereas instances have been recorded when prisoners-of-war developed some of these syndromes a few days after they were put on perfectly balanced diets subsequent to their release [3] & [5] Till such a time when the physiological and clinical implications of the so called deficiency conditions are fully understood, it is expedient that these indexes be not freely and frequently quoted, as it has been done in the past, to indicate the health or nutritional status of population groups. Probably at this stage the issue raised is becoming still more complicated by the addition of another term 'nutrition' in addition to 'health' and 'physical fitness'. But the concept of nutrition would be discussed later on.

CONCEPT OF POSITIVE HEALTH

In the domain of preventive medicine the concept of Positive Health is becoming more and more popular. But in the achievement of that objective the essential pre-requisite is that the term Health should be defined and its limits established in order to grade the condition in its positive aspect. In an interesting and thought provoking article on the positive aspect of health, the author a medical man has sarcastically though very aptly remarked [9] that is presumptuous to profess the science of health when its definition still eludes us. In medical research and teaching scant attention has been and is still paid either to the study of the physiology of positive health, or to the investigations on how human beings react to their environment before finally crossing the clinical threshold. In the curriculum for medical studies enough emphasis is laid on diagnosis and prognosis of diseased states, only with the result that the finished product from a medical school or college often finds it difficult to arrive at a reasonably accurate diagnosis of the health status of such human subjects as may not be actually ill.

'Health' as defined in the Constitution of World Health Organisation 'is a state of complete physical, mental and social well being and not merely the absence of disease or infirmity'. Such a definition is definitely an advance on the traditional negative concept, *of health being synonymous with absence of disease.* Yet it has left much to be desired because the definition is far too broad and vague. Let us hope that comprehensive studies on the physiology of health would be taken up in the near future and thus enable this Organisation to define health with reasonable precision. The fact is well known that in any physiological process, or as a matter of fact in any biological phenomenon which can be determined by accepted methods, the range of variation is often an extensive one. Any wide or noticeable departure from norms, can be easily determined and interpreted as a diseased state of the organism. But within the wider range of any particular physiological process the limits of the necessarily shorter optimum range, which may indicate a condition of complete well being, can only be established after careful investigations. It would also be necessary to determine which of the physiological phenomena or groups of phenomena can be used as the criteria for determining different grades of health in its positive aspect.

NEGLECT OF STUDIES ON THE HEALTH STATUS

It might be very pertinently asked at this stage as to why the physiology of health and its gradation in different levels have not been studied inspite of the rapid progress made in the subject of human welfare by eminent scientists. The reasons which may have been responsible for such a state of affairs deserve to be discussed at some length. For far too long, it had been taken for granted that as long any person was not actually ill no body need worry about him. Very probably it was considered too vulgar or low to bestow a thought on the implications of well being in the human frame when the medical profession, was too busy in the sacred duty of relieving bodily distress of their patients and the physiologists no less occupied in revealing the mysteries of the different organs, tissues and enzymes in the body. Both these groups of scientists each sitting in their own set of rigorously isolated ivory towers were engrossed in their comparatively limited spheres of work, and evidently satisfied with their respective achievements.

It must however be understood that the clinicians and the physiologists are not the only groups of scientists who are to be held responsible for not making serious efforts to define or to study the phenomena of 'health' as a positive attribute. The workers in the field of public health cannot escape their share of liabilities. But every body will agree that an epidemic of Cholera, Plague, Smallpox, Malaria, Typhoid or Dysentery often appealed far more strongly to the imagination of the employers of the health worker and the public he served than an incidence of a lowered state of health or sub-nutrition in any community. Indexes for different grades of health could probably have been evolved earlier if the workers in the spheres of human physiology and public health had realised that they had a common objective, and established a liaison to study the phenomena of health. In the teaching institutions, however the professors of Physiology and Hygiene had very often little scope for contact with each other in the sphere of their academic duties. It would not be irrelevant here to take note of the fact that Hygiene or Public Health has all along been treated as a minor subject in the medical curriculum, and physiology has suffered from the disability of being a pre-clinical subject.

Another major factor which might in all possibility have retarded the development of the concept of health as an individual entity, was the rapid progress of specialisation within the subject of Physiology itself. Specialisation must necessarily lead to isolation of thought and narrowing down of the range of intensive studies and research. The inevitable result has been growth of specialists on each of the different aspects of physiology, of the human organism. Consequently in the strong spate of a specialisation though rapid acquisitions to the store of fundamental knowledge was made, the basic fact, that *human organism is not just a conglomeration of different tissues, fluids, and organs* was overlooked, or anyway crowded out of the main stream of active thought of both medical scientists and pure physiologists. Once in a while people did complain over the paradox that whilst most of the owners of automobiles, sewing machines, and typewriters periodically sent these mechanical contrivances to the workshop for overhaul and repairs with a view to enhance their usefulness and prolong their life, such owners themselves rarely consulted doctors unless they were actually ill. Evidently it was not fully realised by the protagonists of such a thought that in the absence of requisite knowledge on the physiology of the organism in its different degrees or grades of health, such visits of apparently healthy individuals to their attending physicians would have led to the embarrassment of the latter, without any benefit accruing to the well intentioned seekers of health.

EMERGENCE OF NUTRITION AS AN ENTITY

The popularity of the cult of 'positive health' in the domain of preventive medicine was very greatly enhanced owing to the conception and development of nutrition activities with renewed vigour each time, after the three successive cataclysms within the living memory. The first world war, the economic depression of the thirties and the second world war, have made us all realise the importance of health as an entity, a positive attribute, and the extreme necessity for such a concept. All physiologists would perhaps agree to the statement that "there is no other single factor so important to the achievement and maintenance of health as is nutrition." Though the concept of nutrition as a separate entity is barely thirty years old, yet the enthusiasm displayed by its votaries and social workers on the subject, is unique. The pediatrician, the clinician, the physiologist, the biochemist and the public health specialist have made voluminous but useful contributions to the subject. But here again, the human organism has not often been regarded as an integrated whole, though such a precious thought was not spared by the nutrition workers in the researches on better crop production and improved live-stock breeding.

Curiously enough, discovery of the formulae of the chemical entities known as vitamins, their isolation from biological material, their synthesis in the laboratory or in an industrial scale, their behaviour in the natural food stuffs during processing, their application in the cure of so called nutritional stigmata, or their relations to certain bodily functions, have appealed more to the imagination of the scientists and to the lay public alike than the study of the technique for evaluation of the nutritional status in individuals. One very likely reason for this indifference was that investigations of such a type needed elaborate planning and collaborated pursuit of the problem, necessitated by the extreme powers of adaptability exhibited by the human organism in modifying the different physiological functions, under the influence of varying environmental conditions and intake of nutrients. Another inherently disquieting factor was that human beings were not just the type of organisms one would welcome for experimental studies. There has been such a mixture of human races since the first appearance of man on our planet, that it has totally ruined the cause of the students of nutritional physiology in certain aspects. It is extremely difficult to find a sufficient number of people with identical characteristics to serve as experimental subjects, or with the possibility of their organic physiology behaving in the same uniform way as individuals from an inbred white rat colony would do. The climax in this tragedy is that with human beings profound differences are often noticed between offsprings even of same parents. Heredity factors will very likely cause such a confusion until such time as the 'New Genetics' cult of Lysenko be satisfactorily proved, and accepted by the various States for regimented production of human communities purely in the interest of experimental scientists. One other reason why experimental physiologists preferred the white rat or other animals to man was, that the effects of diet or change in environment are felt slowly by human subjects. The observer lives with his subjects in the same rythm of life, and consequently is barely able to complete any long term investigations which may have a bearing on the stature, health or organic efficiency of the offsprings of the subject. But the limitations enumerated should not be considered adequate enough for feeling shy of humans as experimental subjects. Finally there has also been a lack of comprehensive plan on the study of the nutritional physiology of man and absence of collaboration between the workers on the different aspects of the subject.

STUDIES IN PHYSIOLOGY OF HEALTH

Prior to the present decade one was not aware of any concerted, comprehensive, or co-ordinated efforts having been made to study the physiology of health and well being, though it could not be truthfully stated that no knowledge whatsoever was available on the subject. From time to time attempts were made to study the physiology of health in its such special aspects as were of particular interest to the investigators concerned. Most of such studies were undertaken in connexion with the employment of workers in the industries with a view to create better conditions of labour which might ultimately lead to increased production, lessened expenditure on illness of workers, and reduction of financial loss consequent to preventable absenteeism. The researches carried out at the Kaiser-Wilhelm-Institut feur Arbeitsphysiologie in Dortmund or under grants from Industrial Health Research Boards in some of the industrially advanced countries fall under this category. The emergence of the concept of nutrition and its acceptance as an integral part of health work in the early thirties stimulated thoughts on health. The existence of large groups of population in the borderland between health and disease was forcefully brought to the notice of the medical profession and laymen through the efforts of the nutrition scientists. Vitative virtues of the vitamins vaunted in the press caught the imagination of not only the lay people and social workers but that of the medical profession also. The craze for medication with vitamins have in all probability resulted in good dividends to shareholders of manufacturing concerns, but it has made even the lay man realise the possibilities of the health of an apparently healthy person being improved. The pioneer efforts of a few scientists to study the relation of health, well being and disease at the Peckham centre deserves a mention here. This venture was started in the late thirties and is reported to be still in operation. It seems justifiable to presume in the absence of detailed knowledge that in an individual free from recognised clinical signs of diseases, the standard of his nutritional status is almost synonymous with that of his health.

Since July 1940, a sub-committee on Medical Nutrition was created by the National Research Council of the United States of America, and serious efforts were made by at least one country to study the influence of nutritional factors on health and efficiency of human organism. Elaborately planned and statistically designed investigations were carried out with healthy human beings as experimental subjects. Special mention may be made in this connexion of the studies on the physiology of experimental starvation for 24 weeks, and on the subsequent rehabilitation of 36 healthy young men at the University of Minnesota. Studies on the conditioning of the human bodies to withstand the stress of abrupt starvation were made at the University of Tennessee. Other studies comprised the determination of the magnitude of losses of water soluble vitamins and minerals in the sweat under simulated tropical conditions, and the effects of dietary factors on the ability of men to withstand repeated exposures to cold at the University of Illinois, investigations on the physiological mechanism regulating the body temperature of men living in colder conditions at the University of Cornell, assessment of dietary protein requirements of men in active and sedentary pursuits, as also the effects of variations of vitamin C intake on the well being and physical fitness of manual workers at the Harvard Fatigue Laboratory, and researches on the appraisal of physical fitness and working ability of young men at high altitude and particularly in relation to the intake of nutrients of Northwestern University. The physiological relations of healthy individuals to their environments in terms of their tolerance to heat and cold, acclimatization, the relation of nutrient intake were also studied by research units deputed from universities during army manoeuvres. One of the salient features of the studies enumerated was, that the researches were sedulously pursued as problems on national health, The human guineapigs in all these studies are reported to have willingly submitted to the rigorous regimen needed for such studies, and most of all, to live for prolonged periods on prescribed and limited intake of food. The fact however can not be overlooked that such extensive studies were carried out during the expediency of war, and not primarily designed for evolution of yardsticks to evaluate the level of health in an individual or a community. Nevertheless, the data collected and records of observations made are likely to make material contribution to our knowledge on the physiology of positive health.

During the war years and even now some amount of work on diagnostic methodology, particularly in relation to avitamanosis, was and still is, being carried out. The data collected at the various prisoner-of-war camps are likely to be of help in making a choice for the physiological indexes that may be used for assessing the levels of health and nutrition. One is looking forward in this connexion to the publication of the observation made by a special team of the Medical Research Council of Great Britain which was deputed to study the incidence of lowered nutrition in Wuppertal of Germany. The experience of the Nutrition Survey units attached to the Allied Control Commission in Germany, if it be published, may be found useful. A comprehensive and critical review of the data collected in all the investigations referred to, by a group or groups of experts is an essential preliminary for indicating lines on which future studies and observations are to be made by the scientists engaged either in laboratory practice, or in field work with particular reference to nutrition. Public Health scientists associated with nutrition surveys have a special responsibility in the matter as evolution of reasonably precise indexes for the appraisal of the levels of health would bring more advantage to their professional work than to that of anybody else. They will have to secure ardent collaboration of physiologists and biochemists to achieve any degree of success.

WHAT CONSTITUTES HEALTH?

It has already been suggested that in individuals free from any recognisable disease the state of health and physical fitness is ordinarily not different from the state of his nutrition. Mere freedom from disease and the possession of, a good set teeth, a healthy skin, bright eyes, proper redness of mucous membrane, faultless auditary ability, developed musculature, the presence of adequate subcutaneous fat under the skin and such other external signs do not imply that a person is in perfect health. Besides the physical signs enumerated, any person claiming optimum health should be able to perform all bodily movements without any distress, possess the capacity to work for fairly reasonable period of time without diminished efficiency, and further, be able to stand the stress and strain of sudden change in environment. Consequently there can never be devised one fool proof, single yardstick for assessing the levels of either health or physical fitness. Ordinarily in human individuals the important criteria to be judged or assessed may be conveniently discussed under the items: physique, organic efficiency and motor fitness.

(*a*) PHYSIQUE

Evaluation of physique primarily takes into account the impression that any observer may form on the general appearance of the subject under investigation, followed by a systematic examination of the size of the body posture, all round muscular development, chest and abdominal girths, major joints, proportions of bones adipose tissue and muscle in the frame, as also the weight of the subject in relation to his height and preferably to his age. The importance of physique in the determination of the state of health and nutrition came into prominence soon after the first world war. The American War Relief Commissioners and Quakers desired a rapid and objective method for selecting malnourished children for distribution of supplementary foods. In the absence of any reliable yardstick, ratios of various physical measurements which were devised to express body build and physical fitness towards the end of the last century, were taken up avidly by the workers in Vienna and elsewhere to measure the state of nutrition. Anthropometric indexes such as those associated with the names of Quetelet, Livi, Pignet, Pirquet and others have been advocated from time to time but so far have not been proved to be either reliable or satisfactory. Even the A.C.H. index which was suggested by the child health experts in U.S.A. after considerable investigation and trial has proved to be of no value by workers [10] & [11] in India. Consequently, inspite of its obvious limitations, the assessment of weight is still regarded as a sheet anchor for evalution of nutritional status. A solitary observation on weight may have little or no value, unless the norms for height and weight figures applicable to the particular group of population under investigation be known or established. But a series of periodical weight averages for any particular group of population does yield useful information as to whether the nutritional state of that particular group is improving or otherwise. The weight averages for different groups of population were being used as a criterion of health status by British and American units in the occupied zones of Germany and Austria after the second world war.

Wetzel[12] has in the recent years evolved a grid technique of appraising body build and the development of each child during the 10-12 years period of school going age. The grid technique should be viewed differently from other indexes of health because it estimates a dynamic state of nutrition instead of the other measures of a static type referred to earlier. This technique, it has been claimed, would be liable to detect any deviation in the developmental rate and nutritional status, which are presumed to be indentical, of the child under investigation. For each subject, channels of constant physique is formed and at about the age of 6 years and never later than 8 years, thenceforth development continues along an established channel. The degree of inclination of the developmental curve or channel is said to give a measure of the nutritional status, and children deviating from the normal growth pattern can be more easily picked out than is possible by any other method. But the record on the grid cannot predict whether the deviation is of a temporary nature or the duration thereof and if the child is likely to recover its normal rate of growth. Further the grid, cannot indicate the causes that may be responsible for the deviation from normal growth. The point which should not be lost sight of in this connexion is, that there may be fluctionations during the growing period in the life of a child, and as such the observations on the grid system should be extended over a sufficiently long period. Anyway the reports received are not discouraging and deserves a trial at the hands of nutrition workers in this country.

A mention may be made here in this connexion of another index originally devised by Tuxford in 1917 after an examination of 500,000 elementary school children. The index was subsequently modified by the author in 1939 and again in 1942. It is a ratio of weight to height graduated in relation to age. It may have been useful for London school children but evidently of little use outside Britain for certain reasons. Anthropometrical studies have been made particularly in France, Italy and U.S.A. about the determination of body types and their ratings with implications of each type on general health. The main categories of the somatotypes are, Ectomorphs, Mesmorphs, Endomorphs and Medials with combinations of one type with the other. But the technique of somatoscopic classification and rating has to be considerably developed to attain that degree of precision, which its advocates claim, in the appraisal of health levels, and in the accurate determination of each type particularly of mixed ones.

(*b*) ORGANIC EFFICIENCY

Till about three decades ago the degree of health and fitness was judged solely by some anthropometric index related to the height and weight and the performances of the subject with a dynamometer. The basic fact that the firmness of the grip recorded on a dynamometer or an endurance test on a cycle or any other mechanical gadget depended to an appreciable extent on the skill of the performer was either not fully understood or was ignored by the investigators. Similar remarks apply to other tests of performance in the assessment of fitness such as the duration of the period for which the subject can suspend himself with his grips fixed on to a horizontal bar. Even if the question of practice and skill did not come in and interfere with the results, it stands to reason that the muscular prowess of one group or a few groups of muscles could hardly be accepted as an index of fitness of the body as a whole.

Quite early it was recognised as a principle in physiology, that physical exertion puts a strain on the mechanism of circulation and respiration before it can cause exhaustion in the voluntary musculature. Studies in the implications of functional heart test were started in Britain more than 30 years ago, and the importance of recorded differences in pulse rate in recumbent and erect posture and of the rate of recuperation in the pulse count after prescribed forms of exertions was taken notice of. Schneider Index was developed later in the U.S.A. on the above principles, and subsequently adopted by the army and the navy there. But recent work has indicated certain limitations to the test. The test which consists of climbing 5 steps on a chair in 15 seconds under standardised conditions, has been recorded to be lowest after heavy meals and after exhaustion due to overwork, but as the body recovered from fatigue the index rose. But the index does not fully express the power and strength of the subject. The Harvard Fatigue laboratory had developed a 5-Minute Step Test on to a 20″ bench in response to the need for a simple criterion to assess the integrity of the circulatory apparatus. For various reasons the test has not been found to be acceptable to the degree one had expected. The fact is well known to the physiologists that more strenuous the exercise more reliable is the pulse rate recuperation test. But organic efficiency cannot be judged through the performance of the circulatory mechanism alone, though it may be regarded as a major contributory factor to the state of fitness. For a large number of years the vital capacity has been enumerated as an index of organic fitness. It need hardly be emphasised that in major affections of heart or lung the vital capacity is considerably lowered. But in interpreting the results of vital capacity test the facts should not be lost sight of that the vital capacity depends to a very great measure on the integrity of the muscles of the chest and abdomen as also that of the diaphragm and can be increased by practice. Further it is doubtful whether differences in Spirometer readings of vital capacity figures between healthy individuals adjusted to surface area, height weight, temperature etc., would ordinarily be of such a magnitude as to permit of indicating the actual differences in the organic efficiency. Of the other tests for respiratory fitness one may mention of Flarimeter Breath Holding Test and maximum expiratory force recorded in blowing against a mercury manometer. But the latter test is, again, a probable index of performance of the abdominal muscles.

The heading 'organic efficiency' has been used in a wider sense and is meant to include the degree of efficiency or performance of other tissues of the body apart from the fitness of the cardiovascular and respiratory mechanism of the body as a whole. The fact cannot be ignored that the total efficiency of any organism depends not only on the performance of its different organs but also on the condition of its tissues and body fluids. Of all the fluids in the body, blood is probably the most important one, and as such assessment of some of the cardinal constituents in a sample of blood may very likely indicate the state of health of the subject. Haemoglobin and protein are the two important components of the blood which deserve our attention, in this connexion.

The report of the Committee on Haemoglobin Surveys 1945 is an interesting document[13] which sums up the knowledge on the technique of surveys. The report, apart from anything else, has proved the absolute necessity for standardising the methods of collection of blood and the technique for estimation of haemoglobin if the results are to be made comparable. It is but logical that laboratory and other methods used for appraisal of health levels should be free from the pitfall of personal bias, as far as this be humanly possible. According to this Report actual readings between skilled observers may vary from 10 to 14%. Further, personal variability ranged from a coefficient of variation of 1.02 percent to 6.90 percent. Another point of interest is that though colour matching by the naked eye in the technique for estimation leaves enough room for personal bias in the observers, this disability cannot be eliminated by photo-electric colorimeter technique.

Concentration of protein in the serum or plasma has been tried as an index in the evaluation of nutritional status on large scale enquiries. Van Slyke's copper sulphate solutions of different density and a relative density gradient with bromobenzene and paraffin have both been used in large scale surveys by different groups of workers. But it has not been clearly established as to how far the protein concentration can give a definite indication of the state of health or nutrition. Theoretically the logic behind the test appears unassailable, but a review of the observations on estimation of serum protein concentration that have been carried out, indicate that conflicting results have been reported by reputed observers. Keys *et at* [14] have found that serum protein content was barely reduced even after protein undernutrition in subjects led to oedema. The work carried out in India [15] also supported such a finding. Studies on albumin-globulin ratio in the serum have not been convincing either.

From time to time attempts have been made to correlate nutritional status with concentration of some of the vitamins in the blood and other body fluids. A special mention may be made in this connexion to the recent study carried out under the auspices of the Medical Research Council in the United Kingdom on the vitamin A requirements of human adults.[16] Th experimental subjects in this long term investigation consisted of twenty men and three women and they were put on vitamin A deficient but otherwise fully balanced diet, till vitamin A deficiencies were manifest. Except that the value for the carotenoid content of plasma of the subjects dropped rapidly at the beginning, no other consistent changes which could be ascribed to vitamin A deficiency were observed, during the first eight months. After this period however the plasma value for vitamin A started to drop. Four of the subjects did not show any signs of deterioration in rod threshold or cone-rod transition time or in plasma value for vitamin A. In great majority of clinical examinations no significant difference could be noticed between the Vitamin-A-deprived and non-deprived group or in the same person before and deprivation of vitamin A. "This applied to the biomicroscopical appearance of the cornea and conjunctiva, the blood picture including platelet counts, gastro-intestinal abnormalities and the incidence of colds and coughs. The only signs and symptoms which seemed to be commoner in the deprived group, though their significance were doubtful, were dryness of the skin and eye discomfort. Audiometry, however, showed a worsening in the deprived group."

Of the different vitamin concentrations that have been studied vitamin C stands supreme probably on account of the ease with which this vitamin can be estimated in the biological material. But not many extensive studies on plasma concentration of vitamin C have so far been made, and it has been observed that increased vitamin C intake raises the plasma concentration level, though the value is variable depending on the seasons of the year. The present consensus of opinion is that ascorbic acid concentration in the leucocytes affords a better index of reserve in the body than its concentration in the plasma. There is a possibility that estimation of serum phosphatase may help materially in determining early stages of rickets but it is very difficult to prophesy how far this index can be of help in grading states of health and nutrition in subjects free from the possibilities of rickets.

It is yet too early to offer any comments if the concentration of the different complexes of B group of vitamins is likely to afford any clue to the nutritional status of inviduals in apparent health. The relation between the blood concentration of any one vitamin with the state of health or nutrition has yet to be established, and the approach to this problem in the existing state of our knowledge can never be too cautious. The results of saturation test with vitamins may serve as a more useful guide to the state of nutrition, than either their respective concentration in the blood or excretion in the urine. Earlier in the text enough evidence has been adduced to invalidate the reliability of so called signs avitaminosis such as phrynoderma, xerophthalmia, angular stomatitis, glossitis and others, as the sole indexes for rating of over all nutrition in a subject.

(*c*) MOTOR FITNESS

In the assessment of motor fitness strength is an important criterion. Since the time the French anthropologists invented them about 250 years ago, the strength dynamometers are still being used to measure the state of physical fitness. Absolute muscle force of any human subject cannot be assessed because no one muscular action of the human body can represent the total body strength, and the internal and external leverage action of the body cannot be excluded during the contraction of any group of skeletal musculature. Consequently dynamometer readings are taken of the right grip, left grip, leg lift and back lift on the two types of dynamometers available for the purpose. The term motor fitness is being freely used in American literature since the beginning of the second world war. The United States Army, Navy and Air Force have prescribed the indexes such as 'pull-ups', 'Sit-ups', '300 yd. shuttle run' and a few others for assessment of motor fitness. Weight lifting, throwing of the discus, high jumps, long jumps and other physical feats are also demonstrative of motor fitness or bodily strength, but their usefulness in the evaluation of the state of health of large population groups has yet to be proved. Finally the degree of performance in each of feats mentioned above can be improved as a result of special training and practice and individual or maiden performances of the untrained do not often indicate the degree of fitness.

For performances associated with motor fitness next to strength, endurance is likely to be presumed as the most important factor. But physiologists would agree that the power of endurance which an individual can exhibit depends to a considerable extent on the integrity of his respiratory and cardiovascular mechanism as also on his neuro-muscular co-ordination and training. Consequently for reasons discussed already it is doubtful if tests for endurance as ordinarily envisaged and practised can hardly be helpful as a reliable index. In planning investigations on motor fitness it should be remembered that there are two aspects of the problem. The first one is to prescribe or determine the minimum limits of certain performances which may be used to screen out recruits from joining the army, the heavy industries or occupations associated with stress and strain or hazards to life. The other aspect of the study is to find out which of these indexes may be used as a criterion to determine the grades of health or nutritional status, and finally to establish forms for the different grades.

CLINICAL RATING

No review, of the knowledge on evaluation of health status however brief, can be complete without a reference to clinical examination of the subjects. Clinical rating has been used extensively in almost all the countries of the world for large scale surveys of population groups particularly in the routine examination of school children, entrants to all the public services and defence forces and more recently in all nutrition surveys. In school medical examinations the children are ordinarily classed into three or four groups such as 'good', 'fair, 'poor' and 'tolerable' etc., by naked eye clinical examination. It is difficult to controvert the fact that even some of the best examiners, themselves being good clinicians, have differed in their opinions regarding the rating of a small percentage of the total children examined and that some of them have differently rated the same subject if he or she was presented for re-examination before the identical examiner after some lapse of time. The reason for such controversial or contradictory findings is not difficult to comprehend. The differences in opinion and anomalies arise in connexion with the rating of such children who happen to be in the borderline of two adjacent grades. Incidence of such an unavoidable, explicable and possibly pardonable error in obiously small percentage of cases should not invalidate the whole of the data or observations.

In their attempt to be more precise and quantitative in the clinical rating of children various schedules of enquiry have been devised from time to time by several groups of investigators. It may be of interest to nutrition workers in India to know that Professor G. Sankaran of Calcutta had long before any of the others elsewhere, devised a score card schedule of enquiry for rating the state of nutrition in children. Subsequently the score card technique of nutrition rating has been accepted by the Section of Nutrition in the United States Public Health Services[17]. Similar cards have also been used in the Oxford Nutrition Survey omitting the technique of scoring. As a matter of fact the point in favour of scoring is that it helps in summing up the results of observations in terms of measurable and comparable quantities. The Nutrition Advisory Committee of the Indian Research Fund Association, have accepted Professor Sankaran's Score Card with minor modifications and recommended its use in routine nutrition surveys in our country. But the argument against score card, which it is difficult to refute is, that the different variates or the items for examination have been weighed equally in the total summation of scores, whereas they may differ individually in their implications on the health or state of nutrition. Supplemented by laboratory findings the clinical rating has a definite place in the appraisal of nutritional status.

One can easily imagine of instances when any subject who may have scored high marks in tests for physique, efficiency and fitness being graded to a lower category simply because he has exhibited the touch of a clinical stigmata, either in the lids of eye or in the forearm. But the implications of appreciable lesions caused by deficiency conditions even in apparently and otherwise upgraded subjects cannot be ignored. In such subjects the reserve accumulations in the body might have been adequately compensating against any effective or demonstrable ill health. It would be logical to presume that in persons rated to possess optimum health the body should operate with a cumulative deposit account and not on a diminishing current account of bodily reserves. Further it is not difficult to imagine that in the daily physiological operations of the organism if the process of withdrawal of reserves is not halted, the body mechanism will no longer compensate when the reserve store is depleted and disease would result. Consequently in an overall estimate of bodily health clinical stigmata, howsoever small, may have its significance the magnitude of which is not known.

SUGGESTIONS FOR FUTURE ACTION

The primary issues that emerge from the review of health and fitness made at some detail are:

(*a*) A critical study has to be made at the first instance of all published data that may have a bearing on human health. The bran and chaff have to be separated and salient facts that might emerge have to be taken sufficient notice of. And in the light of the above studies definite lines on which investigation on the physiology of health can be carried out in the near future will have to be indicated.

(*b*) Important criteria for assessment of the standard of health, physical fitness and nutrition have to be established. Further, the grades or categories of each of these phenomena have to be defined with a certain amount of precision.

(*c*) Conditions have to be created and facilities afforded by the authorities concerned, for studies on the physiology of health.

It would be futile to pretend that the issue raised are very easy of solution. The difficulties in all their implications may appear formidable and depressing, but they should by no means be considered insurmountable. Sincere and effective co-operation between different groups of research workers in the same country and on certain issues between such workers of different countries will be necessary, in addition to more than usual earnestness on the part of the physiologists and health scientists, to solve the problem. It is needless to add that adequate resources should be made available to the various centres of study for the purpose. If magnetic mines were invented and used by the enemy in the last war, the mine detector could be brought into actual operation within a few weeks with the aid of science. Application of Haber's process for large scale manufacture of synthetic fertilisers, development of Radar and industrial production of penicillin are but instances of achievements made because of the strong will behind each of the projects. Both the world wars and particularly the second one have proved beyond all doubts that given the financial opportunities and time, all problems for conquering nature and environments can be solved with the aid of science.

The problems of health dealt at some length in this address is not confined to one country or a group of countries though the incidence of lowered health and sub-nutrition is very high in certain parts of the world. The World Health Organisation can take a lead in this matter for reasons more than one. The Technical Commission of the Health Committee of the now defunct League of Nations had amongst others drawn up a report on physiological basis of nutrition when the world opinion on the subject was far from being unitary. This Commission consisting of international experts had also from time to time made their suggestions pertaining to the various problems on Nutrition. The World Health Organisation would earn the gratitude of many if they in the first instance appoint an *ad hoc committee* or commission for wading through the records of all investigations having a bearing on the physiology of either health, or fitness or nutrition that have been carried out in the past. The Committee can also indicate the lines on which further investigations are to be pursued in all out effort to define each of the phenomenon and the various categories that may have to be established. The World Health Organisation may subsequently initiate and subsidise a planned research work on the subjects in the different countries. It is but reasonable to presume that the organisation in its professed object and efforts for creating better health conditions may take a favourable view of the points raised.

The different scientists engaged in investigations on the physiology of human organism and his welfare in each country should establish a closer liaison between themselves and collaborate in their pursuit for studies on health and health status. Stimulation of thought on the impact of social and economic conditions on health have led to creation of Chairs on Social Medicine in the recent years. Studies on physiology of health is no less important and the departments of public health in the universities and teaching institutions can with advantage take to this type of work jointly with the departments of physiology.

In view of the national importance of the subject it is imperative that adequate facilities be made available to health scientists in our country and proper environment created. The existing arrangements for teaching of Hygiene in the medical colleges in India leave much to be desired. Hygiene is still regarded as a minor subject and medical undergraduates cannot be blamed if they carry an impression that the subject is of very little consequence in their career except for passing the qualifying examination. In most of the teaching institutions the Section or Department of Hygiene consists of a teacher designated as professor or lecturer and possibily of a non-technical person in addition, who may be appointed as care-taker of a few exhibits or models on public health. Unlike the heads of departments for other subjects in the medical colleges somebody holding a whole time appointment in the local health directorate is often saddled with the additional duty of teaching hygiene to our undergraduates.

In all the other departments of teaching in the medical colleges, a man can work his way up adding to his knowledge and experience from the post of a Demonstrator to a lecturer, a Reader and finally to a full fledged Professor; but the section of Hygiene affords no such change because of its being a department, if at all, manned by one person. The professorship of Hygiene or Preventive Medicine should be made a whole time appointment in each of the medical colleges in this country and the emoluments fixed at such rates as would ensure recruitment of properly qualified persons. Adequate staff, equipment and facilities for research work should also be provided for. Concurrently with the creation of proper sections for teaching of hygiene, the facilities for research work in the departments of physiology should also be enhanced. Earlier a reference was made to the fact of physiology being treated as a preclinical subject.

I can do no better than quote Professor A. V. Hill[18] in this context: "The pre-clinical sciences are the basis of the scientific study of medicine and of what is now called clinical science. If pre-clinical sciences are weak it will almost inevitably follow and it has followed in India that clinical research and the standards of higher medical thought and education will be in a bad way". This point has also been clearly enunciated in the report of the Goodenough Committee on medical education in Britain and published by H. M. Stationery Office in 1944. It is a happy augury that our Minister for Health, the Hon'ble Rajkumari Amrit Kaur, in her address to the Medical Council of India about three months ago has stressed the desirability of having 'at least a nucleus of full-time professorial staff who are disallowed private practice' in 'the different departments of a Medical College' and has further added that 'every department of a college should be encouraged to promote research as an essential part of its teaching'.

Last, though not the least is the problem of recruitment of suitable personnel to carry out researches either in the universities, science colleges or medical institutions. It is a regrettable fact and has also been ably pointed out by Professor Hill in his report quoted above that "scientific service under the Government is not in general comparable in pay and status with the civil service or such as to secure the appointment of the ablest man or to give them the best opportunities for developing and utilizing their talents." One cannot blame young Indians with intelligence,, skill and inititative to take to the Indian Administrative Service or a similar non-technical service with good pay and prospects in preference to scientific appointments in the medical schools, colleges and universities. It would not be in the best interests of any country to create such conditions of employment as would ordinarily detract the top ranking university students from the pursuit of science mainly due to economic reasons. The French Scientist Jean Perrin in a recent publication, has lamented* over the fact that no country has so far made a serious attempt to ensure that those gifted with aptitude for scientific research do not find themselves kept away from it solely through the want of material necessities in life. According to him we have lost many men of genius and that our present existence is surely poor and miserable compared to what we could have achieved even now and if such research workers were able to develop their talents fully.

The Government of the United Kingdom have, as a result of their experience during the last war, resolved that the conditions of service for scientists working for the State shall be such as to attract into the civil service scientifically qualified men and women of high calibre and to enable them after entry to the best use of their abilities. And about four years ago terms and conditions of the Scientific Civil Service were formulated and published[19] to attract suitable recruits. We fondly and earnestly hope that the people and the Government in our country would take note of the hard facts and try to create conditions which will ensure the recruitment of the very best material available from the universities not only to administrative services but to scientific appointments as well. Let us hope and wait.

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* 'Il semble donc insensé que les diverses nations n'aient fait jusqu'ici aucun effort sérieux pour que ceux qui sont doués pour cette recherche ne s'en trouvent pas écartés par des nécessités matérielles. Nous avons ainsi perdu tant d'hommes de génie que notre existence actuelle est certainement pauvre et misérable à côté de celle que nous ménerions, aujourd'hui même, si ces chercheurs avaient pu se developper '.

REFERENCES

1. Lovat Evans. Principles of Human Physiology J. & A. Churchill London. 1947.
2. Mitra, K. (1943 & 1944) Unpublished Reports to I.R.F.A.
3. Simpson, J. (1946) Lancet i, p. 959.
4. Burgess, R. C. (1946) ibid ii, p. 411.
5. Mitchell, J. B. & Black, J. A. (1946) ibid ii, p. 855.
6. Walters, J. H. & Rossiter, R. J. (1947 ibid i, p. 205.
7. Special article, (1948) ibid ii, p. 228.
8. Adcock E. W. et al (1947) Jour. Hyg. Camb., 45, p. 65.
9. Burridge, D. H. D. (1949) Jour. Roy. Army. Med. Cor. 92, p. 77.
10. Aykroyd W. R. & Rajagopal K. (1938) Ind. Jour. Med. Res. 26, p. 55.
11. Mitra, K. (1940) ibid 27, p. 887.
12. Wetzel, N. C. (1941) Jour. Amer. Med. Assoc. 116, p. 1187.
13. Committee on Haemoglobin Surveys (1945) Med. Res. Coun. Spl. Rpl. Ser. No. 252 H.M.S.O. London.
14. Keys, A. et al (1946) Science 103, p. 669.
15. Hynes, M. Ishaq, M. & Morris, L. (1946) Lancet ii, p. 590.
16. Vitamin A Requirements of Med. Res. Coun. Spl. Rpl. Ser. No. 264
17. Sandstead H. R. / Anderson R. K. } (1947) Pub. Hlth. Rep. U.S.A., 62, p 1073.
18. Hill A. V. (1945) Scientific Research in India. Government of India Press, New Delhi.
19. Document No. cmd. 6679. H. M. S. O. London 1946.

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SECTION OF PSYCHOLOGY AND EDUCATIONAL SCIENCE

PRESIDENT: KALI PRASAD, M.A., Ph.D.

Presidential Address

Psychological Research in India.

Progress of modern science is characterised by the uneven development of its three main branches *viz.*, the relatively high degree of control which physical science has enabled us to acquire over inorganic nature, our still very rudimentary knowledge of biology and the almost complete absence of scientific Psychology and Sociology. The consequence has been that while our environment and mode of life have changed profoundly by the application of physical and chemical knowledge, the human organism has had no time to adapt itself to these changes. There has been a great and growing disharmony between the human organism and the highly complex environment which physical science has fashioned around it. This imbalance between physical and technological development on the one hand and our relative ignorance of the social and psychological processes on the other, is a peculiar incongruity of modern times and unless it is corrected there is hardly any chance of social understanding and human progress. But it cannot be corrected except by a *deliberate* modification of the physical environment. We have to give up the complacent belief of the nineteenth century philosopher in the inevitability of progress; we have learnt through bitter experience how that belief was mistaken. We have seen that left to himself an individual or community, like any organic material, may run wild or degenerate. Progress in social matters has to be striven for and planned as assiduously and carefully as in the world of physical phenomena. For, human nature is not some immutable essence which endures through eternity and which the philosopher may only contemplate; it is a fluctuating dynamic pattern determined by complex conditions of life and nature. But change of human nature and the making of man cannot be possible until social sciences are developed enormously; until we have a scientific knowledge of biology, physiology, psychology and genetics comparable in extent and accuracy to our knowledge of physics and chemistry. Until this is achieved, civilisation will always be exposed to the threat of extinction by the very instruments which scientific technology continuously forges. For man is still unable to appreciate their appropriate use and like a child is inclined to employ the products of his scientific genius for display of his physical prowess and sometimes even as engines for the destruction of society and for his own annihilation. The present emotional make-up of man and the extraordinarily crude and inept forms of his social organisation are such that the dangers of abnormal development of physical sciences would continue for a long time. The danger could perhaps be averted if the emotional constitution of man is understood and reorganised, otherwise the combination of our present ignorance about the mechanisms of human motivation along with our knowledge of physical sciences is bound to wreck the whole fabric of society. The misuse of atomic energy by the scientifically advanced countries of today already bears witness to the enormous powers of destruction which discoveries in physical science have placed in the hands of people who are emotionally and intellectually still at the level of infantile mentality. As individuals or groups of men have not learnt to adjust themselves to their social enviornment because they do not know one another and do not have any clear idea of the meaning and purpose of human existence itself.

Our knowledge of man is extremely superficial and inadequate. The barriers in the way of understanding have been largely psychological. We have not yet learnt how to assess adequately the influence of psycho-biological and psycho-social determinants of human behaviour, nor to appreciate the significance of the fluctuating patterns of our reactions as they develop in a complicated social mileu. The complexity of the human organism with its manifold adjustive and reactive modes of responses has been a challenge to the most discriminating psychological analysis and experiment. The technique of investigating these reactions is so imperfectly developed to-day that we often feel sceptical whether psychological data can be subjected to objective, scientific treatment at all. In this atmosphere of uncertainty, a further cause for alarm has been found in the conflict between contending schools of present day psychology. In the present state of psychological knowledge, however, such a situation is perhaps unavoidable. The conflicts of the rival schools are an evidence not only of the youthful character of this science but also suggest that human behaviour is a multidimensional reality which admits of a number of approaches all likely to furnish valuable clues to our understanding of man. The social sciences have, therefore, a difficult task and in the crisis with which modern civilisation is faced the development of scientific psychology is an imperative necessity; for psychology is the basic foundation of all social sciences. Fortunately, there are signs in Western countries of an increasing emphasis that is now being placed on it. The great volume of literature on psychology and the social sciences and the formation of organisations such as the U N O and the U N E S C O testify to the growing anxiety of modern man to understand man. For this reason the modern century has been called a psychological century *par excellence.*

Unfortunately, in India psychological research is still in its early infancy. The comparative newness of the subject, lack of facilities for experimental work, paucity of competent workers and the poverty of equipment of both teachers and students would possibly explain why no distinctive achievement has been made in psychology in this country. In most universities and colleges psychology is grouped as an "Art" subject and is divorced completely from a laboratory setting. It is taught and read like literature or classical language but without the throughness and critical appreciation normally associated with the study of the latter. The student goes through topics such as perception, memory, feeling, emotion, learning, motivation, conditioning, association, sensation etc., without illustrative aids or statistical data—without knowing the experiments on which work on them is based. Even the anatomy and psycho-physiology of nervous system are sought to be understood without any models, dissections, laboratory preparations and experiments. It is like learning physics or chemistry or biology without stepping into the laboratory. Actually the situation is worse, because while no physicist or chemist or biologist would dream working without a laboratory, the psychologist often thinks that since laboratory technique commits one to a particular brand of psychology (such as, for instance, behaviourism or reflexology), one who does not accept this brand is free to develop his psychology more or less independently of experimental and laboratory methods. Sometimes he even boasts of this independence and entrenches in his complacency by the belief that the so-called pattern of pure introspective psychology is quite sufficient to reveal the complex processes of mind and behaviour. While the inevitability of introspective observation in all scientific procedure has never been doubted it is equally obvious that the behavioral situation has so many aspects which lend themselves to experimental study and objective treatment. In fact, the latter approach is so comprehensive that it includes among other things an introspective report and the so-called subjective appraisal of phenomenal experience. The experimental approach is a natural and a logical method of dealing with the date of Psychology as a science. Today it is no longer question of choice: if psychology is to be developed as a science, it has to be experimental psychology in the strictly science sense of the term. And, the little progress that has been made in psychology in modern times is doubtless due to the frank and conscious acceptance of this point of view. It also implies the equally frank and conscious rejection of Pseudopsychological and speculative attitude that psychologists in this country have directly or indirectly brought to bear on the study of psychological phenomena, and this has definitely hampered progress.

The remark may appear to be trite and yet if we examine the matter closely we shall find that it has profoundly influenced our attitude toward psychological research here—Our work in psychology has lacked as much the initial conviction in the relevance of scientific methodology as a persevering faith in a scientific theory as necessery inspiration for the organisation of the data of phenomenal experience. We have neither had the one nor the other with the result that even where research has been attempted much of it has been without design and, of course, without vision. Where a problem has been tackled the method has been imitative or repetitive and the results have been therefore often trivial. No systematic theory or hypothesis in general or applied field of psychology has been developed and in consequence, it has not been possible to make a distinctive contribution in either fold.

Now, there are two fundamental problem in psychological research *viz.*, (1) Constructive effort in systematic and experimental psychology, and (2) research in applied psychology especially in the fields of social psychology and educational psychology. The two problems are bound together so that any advance in one would inevitably influence the other. But it is essential to develop both. In regard to the demand for a theory we may suggest that modern psychology is coming more and more to realise that the concepts developed for instance, by Gestalt Theory provide an adequate basis for understanding at least the fundamental structure of mind and behaviour. In certain fields of behavior *e.g.*. perception, learning, memory, and thought this is already recognised. And as our knowledge of facts in other regions of experience increases, the insight already won will find greater amplification—Meanwhile, we need concepts or rather constructs which would serve to reorganise total fields of experience and make them significant. The system of concepts must be broad enough to be applicable to the most primitive bodily behavior as well as to the emotions, thought—processes, expressions of a concrete situation involving a definite person in a definite condition. These concepts must unify without undue simplification; they must include both person and environment, both law and individual case. These requirements can be fulfilled only if one turns from the prevailing methods of '.abstractive classification" and tries to build 'constructive concepts.' Such an approach would have to be oriented both toward theoretical connectedness and toward concreteness,' that is, it would have to be both constructive and experimental or 'operational' and not speculative and explanatory.

But before such a theory can be understood it may be well to prepare the ground by considering an important change which has come over modern psychology. This may be done, for instance, by contrasting, what has been called the Aristotelian and Galilean modes of thought in contemporary psychology. The distinctive character of Aristotelian science is its appeal to final causes, its anthropomorphic tendency and its *a priori*—deductive method as district from the experimental and hypothetico-deductive approach of modern science. For instance, Aristotelian physics employs normative concepts like 'good' and 'perfect' with reference to circular and rectilinear motions of bodies. For this reason heavenly movements are considered as perfect because they are circular, while sublunar motions, not being so rhythmical, are regarded inferior and imperfect. Likewise, Aristotelain biology uses the concept of perfection or goal and *entelechy* to explain the phenomena of growth and evolution. Every living organism, according to this theory, has tendency to move towards its perfection. Distrubances due to chance make for exceptional cases which must be rejected as refractory. General uniformities and the 'law' constitute the main concern of science; the exceptional and the individual case are treated as deviations from the universal form and as such of no particular consequence.

While physical and biological sciences today have shaken off the Aristotelian influence to a considerable extent, psychology is still under its dominance. The substantial and causal-analytic approach of Aristotelian psychology finds illustration in prevalent distinctions between 'normal', 'abnormal' or 'pathological', 'errors' and 'success'; memory and forgetting etc., as absolute categories. All these are classified according to the value of their *products* rather than that of their *process*. The direction and character of response are supposed to be determined *a priori* by the essence of purpose or 'goal' of behavior-pattern rather than the object and the situation taken as an integral whole. The Aristotelian view stresses the 'historicity' and 'frequency' of a phenomenon; while modern psychology tries to get rid of the historical 'bent' by reference to the concrete whole, the objective process, or, raher the 'process differential', as it has been called. In place of the 'law of frequency', modern science puts forward the principle of 'general validity' which far from considering the exceptional or the individual case as an aberration looks for hypotheses which accommodate it. In place of dichotomies and divisions, a process of homogenisation is aimed at and psychological laws attempt to proceed from the average to the 'pure case'. The contrast is best exemplified by the distinction between class-theory and field-theory. A class concept is primarily based on *a priori* or intuitive ground, independent of individual cases, while a field [illegible] is inevitably moored in the [illegible] cular phenomena derive their significance from the primitive concept which they seek to illustrate and represent; according to the field theory, they are basic to any law of general validity which is impossible to attain without them.

The class-theory is always concerned with the types of phenomena which would exemplify particular cases conforming or belonging to the class; the field-theory suggests logical constructs which are based on the dynamical properties of the experienced situation. 'The field theorist *orders* his experience to these logical constructs.' In so far as his phenotypical experience may be so ordered to these genotypical constructs that he may deduce what his subsequent experiences will be, he considers his scientific analysis successful. Explanation of an event consists in adequately describing the underlying genotype and in seeing if the phenotype (experience or data) may be precisely *ordered* to it. Laws are descriptions of genotypes'. It is here that field theory has a great advantage over the class theory. When the laws (genotypes, underlying dynamics) are sufficiently well known to admit of measurement, the future may be predicted independently of the past. For instance, the law of the falling bodies holds universally even though there are great differences in individual situations of the various objects. But in psychology a law is always difficult to attain on account of genetic, historical and other factors. Thus while physics has already made a transition from the phenotypical to the genotypical stage and biology is making its psychology has not yet made it, though it is on the thereshold of such a change.

This change is already marked in discarding or radically modifying certain traditional postulates such as, for instace, the causal-analytic view, the theory of universal psychical determinism and the overruling unity of mind. These have dominated psychology throughout and are only now begining to be seriously questioned, for it is realised that their uncritical adoption has prejudiced scientific understanding of human behaviour. This is not the place to examine the three concepts mentioned above, but a word may be permitted about the functional-dynamic approach implicit in field theory which replaces them and which would seem to provide a satisfactory basis for scientific psychology. According to this view human behaviour is a complex whole which varies as the total interacting set of conditions change. There is no simple, direct or symmetrical relationship between the stimulus and response such as be expressed in terms of the causal nexus. In actual behavior the physical reality of the stimulus plays an unimportant part: its 'psychological reality' is its most essential aspect. The stimulus situation serves to organise or restatify a behavior-pattern through available energy systems. In this way certain tense psychical systems occur with their own vectors seeking to give direction to an action-pattern in the environmental field. The so-called inner and outer environment are 'charged' by the process itself. But there is a steering of the process by the total perceptual field. A behavior-process is an effect or a resultant of the cumulative operation of various causal factors but is a function of the dynamics of the situation as a whole. When an existing psychical tension—a wish, a need, a half-finished activity etc., finds outlet in motor discharge, a new equilbrium is set up and the objects acquire 'valence' (positive or negative).

dynamic and fluid character of response patterns. The reaction field embodies various kinds of stresses and strains where the unity of the individual is no permanent essence but represents only *functional firmness*. The whole process moves in the direction of a state of equilibrium only for the system as a whole. When system as a whole which is dominant at a particular moment may be taken as the basis of the so-called unity; though there are relatively stable systems which dominate the others and give uniqueness and individuality to the whole (as when a complex determines an individual's action patterns to the whole (as when a complex determines an individual's action patterns and colours his memories, thoughts, perceptions and emotions). It is a state of moving equilibrium. But state of moving equilbrium in a system may also involve tension. A system may come to equilbrium in a state of tension as a spring in tension, a frustrated wish, a half-finished activity, and a long-forgotten sorrow. Considerable functional firmness would thus seem to characterise certain psychical systems. The functional firmness is determined simultaneously by the so-called internal and external conditions, or rather by psycho-biological and social-environmental milieu taken in their indissoluble wholeness.

The psychical processes are really life-processes developing in their own life-space; they are embedded in the individual's life in an environment. Life-space would appear to have at least two dimensions; loco-motion and reality-irreality. Behaviour implies movement or ability to make a transition from one sector or region to another in the field of experience. There are barriers and boundaries which are sometimes comparatively inflexible but often they are permeable and permit considerable locomotion within a limited region. But movement may also be one level to another such as when we from the plane of physical reality to that pass the 'irreality or, rather, the reality of psychological domain. A vague fear, a day-dream, a phantasy is generally regarded as less real than action based on the immediate needs of a person. But apart from the fact that actions themselves have different degrees of reality, the images and phantasies may sometimes have a much greater psychological reality than the surrounding objects in the environment. It is common knowledge how behavioral trends are sometimes completely dominated by theses so-called 'irreal' processes.. There is considerable experimental evidence to show that the degree of reality is an important dynamic property of psychological phenomena. The various levels of reality may be, however, operative at the same time though in different degrees in an individual. Even when a person has taken flight into phantasy, he is still moored in the 'real' world of physical being. But in extreme cases this influence of one level on the other may be so greatly weakened that there is a split between the two as, for instance, in schizophrenia. Normally, there is a development of life-space to the highest plane of reality as one passes from childhood to maturity. This development is a function of the differentiation of a person and his enviornment and represents stratification of levels of different degrees of reality in the course of experience. How behaviour develops and what events occur would thus depend on the relationship between the different levels and particularly on the directed magnitudes (vectors) in the psychological field.

This dynamic field theory lays the much needed stress on the fluid characplemented in an important manner. The behaviour trends of an individual cannot be adequately understood unless the unconscious dimension is also taken into consideration. All normal behaviour in some ways shows character traits which are the socialised residues of infantile psycho-sexual urges. The frustrations of early childhood (including perhaps the trauma of birth itself) continue to colour one's modes of behaviour unconsciously throughout life. The individual overcomes these early frustrations by building up various unconscious mechanisms such as sublimation and reaction-formation. Though the normal adult succeeds in adapting his libidinal and aggressive urges to the demands of society, he still carries these early strivings with him in his unconscious mind. When they are strongly reactivated through some events of adult experience, they lead to distinct forms of neurosis, otherwise, these id forces continue to express themselves in socially acceptable behaviour. The normal and the neurotic, the genius and the psychotic, alike represent attempts at resolution of unconscious conflicts and frustrations seeking the most efficacious and economical symptomatic-behavior in varying situations of life. The two urges- Eros and Thanatos, life and death instincts which may be probably aspects of some even more primitive tendency lie at the base of the unconscious and keep continually asserting themselves. Whether the one is more dominant than the other, whether the death instinct is being continually thwarted and neutralised by erotic urges until it finally triumphs are questions which tend to take psycho-analysis into the domain of metaphysics into which the psychologist can ill-afford to stray. Nevertheless, their fundamental ambivalence is a dominant characteristic of all behaviour and supplies its deep-lying motivations. Thus, in view of its pervasive character the dynamics of the unconscious would be essential for formulating any field theory of mind or behaviour such as the one we have been attempting to present.

The field-theoretical approach is specially suited for experimental work. It evidently provides an adequate basis for the development of psychological research because it starts with no *a priori* assumptions concerning the character of the behavioral field. It employs phenemenological method in objective observation of behavior-data and proceeds to view them in a complex psycho-biological and social milieu. Under the guidence of this theory research in the various branches of psychology can be developed without the cramping influence of certain pseudo-psychological and speculative ideas such as, for instance the theory of instincts as isolated and inexplicable sources of energy, or the theory of (unchanging) human nature or the mnemic theory of memory or the syllogistic theory of reasoning or the theory of the irrationality of the insane and the child etc. The two fields where research is especially necessary in our country today are educational psychology and Social Psychology. Let us examine briefly the type of work that may be done in these.

Educational psychology has obviously a very large scope with a bewildering variety of problems. But our educational research has to take some of these problems which are in many fundamental ways different from those in Western countries and are peculiar to the conditions in our country. Uncritical acceptance of foreign models will only retard progress and hasty improvisations which characterise so many post-war (and post-freedom) programmes would be disastrous in the domain of educational theory or practice—I may give here in the briefest possible manner schematic description of some of these problems which require detailed scientific investigation. We may broadly classify educational problems under four major heads:

1. Those concerning the individual *i.e.*, the child, his educable capacity his normalcy or otherwise etc.,
2. Those concerning processes or mechanisms of educations, like school organisations, curricula, examinations, syllabus etc.
3. Those relating to the determination of the fitness, aptitude, and individuality of the teacher, his emoluments, his economic and social status and
4. Problems in education, its relations to art, aesthetics and culture.

It is impossible to dwell upon all these here. We may single out the first one, *viz.*, relating to the child as the educable (or ineducable) unit. This breaks up to at least in the following four groups of problems.

(1) Problems concerning intelligence testing and mental dificiency or subnormality.
(2) Problems of educational measurement.
(3) Problems relating to measurement of individual differences.
(4) Problems of social adjustment, emotional stress and personality profiles.

Under the first head may be mentioned problems relating to the determination and measurement of a child's intellectual status or mental capacity; his intelligence quotient, correlational studies of intelligence to speed, accuracy Intelligence of Subnormal and gifted children; Racial difference in intelligence; Factorial analysis of intelligence; Intelligence and school marks; speech defects, eye defects; deaf-mutism and intelligence, stuttering and stammering; intelligence and left-handedness; educational retardation. construction of intelligence scales; revision and readaption of Binet-Simon Tests; performance- test for children of high grade and low grade intelligence etc., etc.,

Under the second head may be mentioned measurement of the amount of language development; suggestion effects; effects of hand-writing on grading, correlation between various subjects (*e.g.*, English Mathematics, Science and Languages, History etc.) ; High School Composition; effect of verbal and written examination, vocabulary and school results; spelling studies. scholastic and general attainment tests; reliability of school grading, etc.. etc.

The third group includes problems relating to measurement of individual differences such as determination of image-type the Eidetic type (B or T type); differences according to age, sex, environment, parental vocation, etc.; hereditary tendencies and traits; mental capacity of twins, comparison with foster children; orphanage children, children brought up in special circumstances (gypsy children, criminal tribes" children, wolf children) etc., etc.

The fourth group comprises problems such as leadership in pre-school children; emotional stability and instability; the psychology of class room, examination room; children's fears; their loves and hates. their attitude towards younger and their elder boys and parents and teachers; children lies; studies of certain types of children such as the neurotic type, the pampered type, the obstinate child, the excited and irritable type, the obsessive child, the timid child, the thieving child, the criminal child etc., the child from poor homes, broken homes, the only child, the overgrown and the undergrown child, etc. etc.

Some work has been attempted on some of the problems mentioned above. For instance, intelligence tests, achievement tests, and aptitude tests, have been prepared for certain groups. Certain studies of delinquency have also been made. But all these have been inevitably confined to provinces where they have been undertaken. They have very limited application. We have yet to have a scale of intelligence which would give a reliable measure of the intelligence of children sampled from various parts of the country. Modifications of Binet Simon, Terman-revision, OTIS tets and others have been attempted, but usually they bear strong local colour and cannot be applied to regions where they did not originate. Individuals have very often worked in isolation sometimes even without knowledge of parallel investigations not to speak of any collaboration or cooperation between workers in the same field. The notorious unreliability of age records of children and great differences in the culture and social strata from which they come are such serious difficulties that they have effectively prevented the spread of the mental tests movement in this country. But these difficulties can be met to a large extent by large scale sampling from representative regions and careful adaptation of tests. There are two other ways of overcoming this difficulty: (1) by stressing psychological experimentation and (2) by developing achievement or accomplishment tests in education.

As we know the distinction between psychological testing and psychological experimentation is not absolute. It is true that psychological tests aim at revealing the characterstics of persons while psychological experiments seek to reveal the characteristics of mental processes. But any adequate appraisal of the mentality and personality of an individual would obviously call for an understanding of the nature of his mental processes. If it is proposed to rate him on general intelligence, introversion or interest, the question of what these tests really are is certainly involved; and until it is answered thoroughly satisfactory tests cannot be constructed. Actually the two lines of work are now converging. Workers in the field of psychological testing are becoming more and more concerned with the nature of the processes with which they try to deal. Test data are supposed to throw light not only on individual traits of a person but also on the nature of the mental processes and organisation of the mind as a whole. For instance the factor analysis of intelligence proceeds on this consideration— In this connection Thurstone's factorial study has led to the conclusion that performance on a certain set of tests involves at least seven mental processes— numerical facility, world fluency, visualisation of space, memory for words, names and numbers, perceptual speed, verbal reasoning, and induction. And, as is well known, Spearman holds that most mental test performances demand a general factor which seems to consist of a general intellectual energy. Similiarly experiments on memory, learning, imagery, perceptual acuities, reasoning etc., would undoubtedly help one to asses an individual's a clue to an individual's mentality. Experiments and tests have different purposes and different orientations but they supplement each other and both should be worked together to yield an estimate of a person.

Again, intelligence tests and educational or achievement tests have a great deal in common. While there may be serious obstacles in the way of constructing a national intelligence test today, we can develop achievement or accomplishment tests for school children in school subjects such as reading, arithmetic, spelling social studies, science, geography, languages etc. It is recognised that a well-chosen and diversified set of educational tests measure psychological processes quite satisfactorily—Lorge has shown that the combined standing of a group of subjects on a reading test and an arithmetic test could be undertaken as an index of intelligence much in the same way as any suitable test of general intelligence. But the educational tests must be broad and general in its reference and not too strictly limited to trivial details of a pupil's text book.

Present day curriculum will have to be modified so as to allow room for different type of school books. Educational "Texts are directed not only to the memory processes and information, but to the problematic thinking, the drawing of inferences from data, the application of generalisation to specific problems and situations, study habits practices, appreciation insight etc., "Thus constructed they are apt to stress psychological processes generally and are bound to provide a clue to the understanding of a pupil's mental status.

Lastly, performance tests will have to be used far more extensively than has been done so far. They will appear to have special usefulness in the peculiar conditions of our country. It is true that as a measure of general intelligence they show only medium to low correlation with customary criteria such as results on standard intelligence tests and schools achievement. But where the latter are not available as in our case, performance tests may be the only means of ascertaining mental status. There are a large number of performance tests but they are all based on the three well-known scales *viz.*, (*i*) Pintner-Patterson scale of performance test, published in 1917 and revised in 1937; (*ii*) the Arthur point scale of performance tests and (*iii*) the Cornell-Coxe performance ability scale. Any one of these could be used with necessary modifications and adaptations. Such tests overcome the excessive verbalism of the ordinary intelligence tests and would make it possible immediately to arrive at some psychological estimate of vast populations of children who are illiterate. Also, they make it easier to discriminate between the bright and the dull and the defective. They often have clinical value and may indicate certain type of mental and emotional disturbance. Even though in view of their emphasis upon speed, manipulation, dexterity, neural control, visual memory etc., they embody a different conception of intelligence from that represented in the standard tests of general intelligence, still in the present situation they have unlimited scope and may be recommended for extensive use. When a national general intelligence test is constructed they could be used as a valuable supplement.

We shall now pass on to the consideration of certain important problems which await investigation and research in the field of social psychology. Here the field theory is specially appropriate—as we have said earlier the major problem of mankind is to develop a scientific understanding of the pervasive characteristic of man. The world is full of national and "racial" groups with their distinctive culture and social background. Within the same national groups children and adults are distinguishable on the basis of differing personality patterns. Even when genetic factors are held as constant as possible that is, where there are several children of the same parents in family, children are distinguishable from one another. Children of the same family may vary considerably with regard to intelligence, physical strength, memory, and thinking behaviour, responsiveness to cultural demands etc. The variables are numerous and our knowledge of these concomitant factors which influence personality development is quite incomplete. In addition, there are fortuitous circumstances such as the order of birth, changes in family structure, rejection by one or both parents, the number and sex of siblings; the loss of one or both parents, the tribe and class to which one belongs. The situation is further complicated in our country by the rigidity of the caste system to which one is irrevokably born. There is no permeability and locomotion between the caste-barriers and whatever may have been its metaphysical or orthodox philosophy, psychologically and socially the results of the system have been disastrous. Above any other problem this is the one problem which has to be immediately tackled by all the resources which psychological knowledge has placed before us. Legislative and economic changes are undoubtedly required, but the question is fundamentally psychological, *viz.*, that of changing the mind and attitude of our people. That there are bound to be some kind of stratification in all societies is not doubted. But where our stratum in completely sealed of from another it leads to the development of patterns of personality-responses which are basically determined by anxiety, feeling of insecurity, fear, suspicion, jealousy, mistrust, hatred and exploitation. And this just what characterises the caste or the communal mind in our country. Each cast develops, what one might call, its characteristic mental-pattern and behaviour attitudes which have their moorings in fear, anxiety and hatred. These feelings may be rooted in totemistic taboos and traditional beliefs or ritualistic or religious unction and metaphysical illusions. The contents of these feelings includes fear intolerance, arrogance and superiority urge of its reaction formation as extreme submissiveness and wirthlessness and cynical disregard for other groups and classes. As a child the individual belonging to a caste-group grows up in habits of behaviour which later appear as *natural* to the group. It is not recognised that the naturalness of the caste or communal mind is itself a product of long process of socialisation and that if a different mental set-up is desired it has to be worked for from the begining i.e., from the time of the birth of an individual in a familial-social milieu.

In order to achieve this end, field surveys of families have to be undertaken. A study of their customs, beliefs, superstitions, social habits, birth, marriage and death rites, their specific culture trends etc., has to be made. Some of this could be ascertained by carefully devised questionnaires or situation-tests and other kinds of projective techniques. In western countries similiar studies have been undertaken with profit. The following [illegible] work may be mentioned as examples of the lines of research [illegible] up in our own country. Does culture affect Patterns of [illegible]? by Denais; Social determinant of the level of [illegible] and Vollmann: skin colour judgements of [illegible] students by Marks;

social factors in moral judgement by Pigget; verbal stereotypes and racial prejudice by Katz and Braly; hostility and social frustration studies by Sears, Bateson, Dollard, Maslow, Dembo, Lewin etc.; measurement of social distance by Bogardus; social status and child rearing by Ericson; Anti-democratic Personality by Frenkel-Bursswick, Lavinson and Sanford; psychology of rumour by Allport and Postman; war and peace by Kluckhohn etc. etc. To these may be added own distinctive problems such as the study of group or caste differences in various psychological dimensions, such as aggressive or submissive characterrstics; religious orthodoxy and strength of traditions or unorthodoxy; social, moral, rigidity or otherwise etc. There are probably characteristic attitudes in certain groups such as may be symbolised by what might be called for purpose of methodological convenience the 'Brahman mind,' 'the Bania mind,' 'the Kshatriya mind' etc., psychology of Indian women; study of the upper and lower middle class; the mind of the rural worker; the urban worker; the psychology of priesthood; the psychology of so-called scheduled caste and the artificially isolated, 'untouchables' and the equally artificially created criminal tribes etc. etc.,

Social reform would be impossible without a detailed and dispassionate investigation into the foundation of our social structure. So far we have had social workers who have brought to bear emotional or romantic attitude on these problems. They have neither had the equipment nor the incentive to study them scientifically. This is perhaps one reason why the remedies suggested have been either too idealistic and utopian or too superficial with the result that the main structure of our society has remained in all its essentials as it was given several hundred years ago. The last few centuries which have seen the rise of Science and the transformation of the western civilisation have largely bye-passed our country which has retained its mediaeval mind and outlook in these modern days. This mediaeval mind has to be re-educated and changed and overhauled. For this we have to develop a technique of *social engineering* based on psychological analysis and understanding. We have to dig up the past and excavate the foundations of our basic culture to seize upon the abiding elements in it. For, we cannot build without utilising certain materials which have been acquired through long process of trial and effort and the travil of experience or which have been obtained by extraordinary insights of the ancient builders of this land. They have to be adapted and refashioned by a process of creative synthesis into a structure which will be suited to present needs and will be responsive to the dynamic rapidly changing world of today. Our culture and our spiritual heritage have a message of peace for the war-torn world of modern man. But it has to be assimilated and learnt by ourselves first before we can play the evangelist of our religious catholicity, and our spiritual granduer. At the same time we have to guard against the very real danger of revivalism and the resuscitation and accentuation of mediaevalism. There could be no greater national catastrophe than a realapse.

The psychologist is destined to play an important part here. He must take up social problems in the concrete setting in which they occur and apply tools which modern scientific technique has placed at our disposal and which have already proved useful in several fields. Following the field-theoretical method he may see that behaviour occurs in a social field which is a topological rather than a metericised field. It is a continum of many dimensions. An individuals social behaviour is characterised by his membership-character within a field region and the degree of his social locomotion would depend on the number and character of barriers in that region. The bership-character within a field region and the degree of his social locomotion between its division because the whole structure is taken as a static and rigid body. On the other hand social psychology must employ concepts which emphasise dynamic behavioral fields where an individual's responses are seen to flow from a totality of factors (conscious and unconscious) operating in different ways.

A student of social affairs must attempt to investigate these factors and assess their influence and try to gain an insight into their operation. In this way he will acquire a sympathetic understanding of individuals or groups and their distinctive behaviour-patterns. Our need today (as much as the need of the world) is to develop this understanding of the operation of my neighbour's mind. And, in stead of looking upon the process of his thinking and reasoning as warped and inevitably mistaken we may pause to analyse and understand the deep-lying mechanisms of his motivation and the complex social-biological influences which give direction and relevance to them. These mechanisms and influences, these vectors of his mind, have to be investigated and given other directions and different orientations. And, since tensions and conflict rise in the mind and are often due to impatience or lack of social understanding, they must be studied and analysed and attempt should be made to recondition the individual or the group affected to healthier or more approved modes of action. This process of re-education and changing settled reaction patterns is the great task before psychologists educationists and reformers alike. But the main responsibility rests with the students of human mind and behaviour.

The psychologist must take advantage of the democratic process which is coming more and more to be recognised as a way of life which offers maximum opportunities for an individual's development. It is true that we have not yet attained a satisfactory understanding of this process in our country, but we must help educate men and orient them to it and build in reactions which would develop it. Strictly, the educator and the psychologist have to be one and they both must bend their energies to the great psychologists, educationists and reformers alike. But the main responsibility is task of changing attitudes and training us for democracy. But the social psychologist must not aim at a dead homogeneity where individual differences are utterly levelled down and patterns of behaviour are thoroughly regimented. The psychologist on the other hand, aims at what has been called 'orchestrated heterogeneity' where individuals make their distinctive contribution and at the same time heighten the tone of the whole society.

In summing up I may be permitted to conclude by making a few suggestions:

(1) The present world order with its tensions and conflicts makes research in the individual's mind and his reactions imperative. If the present civilisation which embodies elements of undoubted excellence has to be saved, a great deal of emphasis must be laid on social sciences and the development of scientific psychology which is basic to them.

(2) For this a field-theoretical approach in psychology seems to be an appropriate view-point which must guide and organise psychological research in systematic psychology as well as in applied fields.

(3) The two fields which demand immediate study are educational and social phenomena. Mental testing has to be strengthened by systematic research in experimental psychology, and before standardised tests of general intelligence are made ready, work on achievements tests may be emphasised as fairly valuable supplementary information about an individual's mental status. In social psychology work must begin by field surveys of families and groups for understanding deep-lying motivation of age-old habits, beliefs and customary behavior such as caste-consciousness and caste-behavior.

(4) For this purpose a Council of Psychological Research may be constituted which will meet at least once a year to review research-work done by various workers in the field, to offer facilities to them and to coordinate their activities. It will publish a report giving details of the main lines of research carried on by psychologists at various centres. In addition it may undertake some other task such as to (*a*) prepare a dictionary of psychological terms in the national language, (*b*) maintain a list of workers, (*c*) publish research monographs, (*d*) encourage research in the design of apparatus and instruments, (*e*) and to develop contact with psychologists in other countries, try to invite experts and organise special courses and lectures by visiting and exchange professors from abroad and in the country.

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SECTION OF ENGINEERING AND METALLURGY

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Presidential Address

THE ROLE OF SCIENCE ON INDIAN RAILWAYS

I acknowledge with great appreciation the unique honour which you have so kindly conferred upon me by electing me as President of this Section. On going through the list of distinguished men who have held this office before, I find that I am the first railwayman who has been so honoured. This is really a cause of sincere pride to me and to the railway administration to which I belong.

I have been intimately associated with the scientific organisation of Indian Railways for over two decades and as such I am fairly well acquainted with this Industry, and this is the main reason for my selecting this subject of "The Role of Science on Indian Railways" for my Address.

As someone has aptly remarked, the history of civilization is in fact the story of transport. Probably the earliest means of transport was the animal on which men sat and carried their possessions. It is true that Transportation is synonymous with Civilization and it is not possible to make any great improvement in the health and education in the villages of India until they are within easy reach for which organised transport is the surest means of approach. We so often use the word path or road to civilization and our national emblem 'Wheel or Chakra' in a way truly signifies this national Railroad industry.

The total track mileage of Indian Railways before the partition was 40,945 miles consisting of 20,952 miles of B.G., 16,109 miles of M.G. and 3,884 miles of Narrow Gauge. After the partition the total mileage of Indian Railways at present is about 34,000 miles as compared with 7,000 miles of Pakistan Railways (E.B. and N.W. Rlys.)

So far as Indian Railways are concerned, the above mileage works out to be one track mile for every 38.5 sq. miles of area of this country, whereas Europe with an equal area has five times the track mileage of Indian Railways.

U.S.A. with a population, one third that of India, has a total track mileage of 250,000 miles which is more than six times that of Indian Railways. Great Britain with a population of one tenth that of India has a track mileage of 50,000 miles.

In India there is a considerable gap between actual demand for transport and the capacity of Railways to meet it adequately. The problem of bridging up this gap is one of acquiring more power, more Rolling Stock and increased Line Capacity.

During 1947-48 Indian Railways had about one million employees on their roll, the total cost of which amounted to Rs. 50 Crores or roughly speaking Rs. 14 lakhs per day but the above figure has increased by atleast Rs. 20 Crores due to the implementation of Pay Commission's recommendations.

As compared with this expenditure, the American Railways annual wage bill for the year 1929 was of the order of 2500 million dollars which roughly amounts to Rupees Two Crores and Eighty Lakhs per day.

Indian Railways spend over Rupees 40 Crores every year on the purchase of stores which range from a pin to a boiler & these consist of thousands of items. It would be interesting to note that the British Railways Stores Purchase Bill amounted to 53 million £. (Rupees 80 Ctores) last year and so far as American Railways are concerned they spend over Rs. 500 Crores every year. In every part of the world Railways are the largest buyers and users of material and in this respect Indian Railways are no exception. I give below a short description of some of the important material used by the Indian Railways.

COAL USED ON INDIAN RAILWAYS

The coal requirements of Indian Railways is about 1/3rd of the total coal-raising capacity of India. The railway requirements are generally of the order of 8½ to 10 million Tons a year. The total probable world reserves of coal of all grades within 6000 ft. of the surface are estimated to be nearly 74 Million Million metric tons or approximately 16,000 times the world's present total annual consumption. Out of these estimated total reserves 51.8% are located in U.S.A., 16.4% in Canada, 13.5% in China, 5.7% in Germany, 3.1% in Russia, 2.6% in Great Britain, 2.2% in Australia and 1.1% in India. According to the latest geological survey report of India the total reserve of Gondawana coal of all grades upto 1 ft. thickness and depth of about 2000 ft. comes to 60 thousand million long tons. As mining is not practicable with seams narrower than 4 ft., the workable total reserve is reduced to 20 thousand million tons of coal having not more than 25% Ash. The coal consumption in India per capita is calculated to be .07 tons as compared with 6 tons in U.S.A. The U. S. A. today produces over 800 million tons of coal per year, out of which the Railroads uses as much as 150 million tons for their requirements. If the loaded wagons of coal for use on American Railroads for a year are kept standing on a track they would have a length of 24000 miles or a distance equivalent to the circumference of the earth. In India, Railway Industry uses the largest quantity of coal, which is approximately 8½ million tons a year. In a modern steam locomotive, 70 to 80 Lbs. of Bituminous Coal is used per sq. ft. of grate area per hour. Taking the grate area of 50 sq. ft. for our B.G. locomotives it would amount to roughly 3750 lbs. of coal per hour per locomotive. According to the experiments done in U.S.A., about 1/5th of the locomotive fuel is used at periods when the locomotive is not doing any useful work, i.e., in firing up, waiting for trains, standing on sidings and passing tracks, delays at terminals and waiting at ash pits. Although all this appears to be a waste but it cannot be considered as such, as the locomotive must spend sometime in yards, terminals and sidings. All these are essential activities incidental to operation, but these periods must be reduced to a minimum as far as possible. Now the remaining 4/5th of the fuel used by a locomotive is consumed for hauling trains. It would be interesting to study the distribution of this fuel when it is actually employed for operation. It has been estimated by experiments done in U.S.A., that 70% of coal used is applied for making steam, the remaining 30% being used as follows:—

14% goes out of stack as hot gases. This can be easily verified from the fact that 1 ton of coal requires approximately 12 tons of air and this air is heated from atmospheric temperature i.e. from 70-80°F to 500-600°F while leaving the stack. 8% goes out of stack as cinders, 4% goes out of stack as unburnt gases, 4% goes out of the firebox in Ash pits.

Now out of 70% of coal which is applied for making steam, 5% is lost by radiation, 6% in air-pumps and blowers, and the remaining 59 % goes to cylinders, and of this 52% passes out as exhaust steam thus leaving only 7% for work at the draw-bar, and even out of this 1% is used up in overcoming the friction.

The above heat distribution ratios, although taken from American experimental results, are equally applicable to Indian Railways. Any effort made in this country to reduce these losses even by 1% would show a saving of 70 thousand tons of coal per year which is equivalent to 20 lakhs of rupees.

It is probably not easy to appreciate the significance of the amount of coal used by Indian Railways. The total annual coal requirements of Indian Railways is such that loaded wagons when kept on the track will cover a distance of 3500 miles. The coal requirements of Indian Railways for the month of August 1949 are given below:—

Class I Railways:		
E.P.Rly.	51	thousand tons
Assam Rly.	7	,, ,,
G.I.P. Rly.	152	,, ,,
E.I. Rly.	250	,, ,,
B.B & C. I. Rly.	94	,, ,,
O.T.. Rly.	56	,, ,,
M.S.M. Rly.	73	,, ,,
S.I. Rly.	36	,, ,,
B.N. Rly.	129	,, ,,
Jodhpur Rly.	7	,, ,,
Bikaner Rly.	5	,, ,,
Nizam's State Rly.	17	,, ,,
Mysore Rly.	9	,, ,,
Sorashtra Rly.	12	,, ,,
Class II Railways	4700 tons	
Class III Railways	8300 tons	
Total	910 thousand tons per months	

Taking the cost of coal at a flat rate of Rs. 30/- per ton it amounts to Rupees two Crores Seventy-three thousand per month or approx. Rupees Thirty Crores a year.

Briquetting of Coal Dust:—It is a well known fact that a great amount of coal slack or dust is produced at the collieries as well as in the course of transit, i.e., while loading and unloading. This can be easily verified from the fact that over one million ton of coal slack is lying at the collieries which cannot be used. These coal fines apart from being unsuitable for firing in Locomotives are in fact a source of fire risks. Railways have been trying all sorts of ways and means in India to use up these fines in some suitable manner but apart from making a few briquettes with binders such as coal-tar, pitch, bitumen and cowdung no substantial advancement has been made in this line. Apart from cowdung all other binders are very expensive and represent about 60 per cent of the cost of coal for briquetting it. The use of cowdung is of course prohibitive on account of its national importance as a fertilizer. In my opinion its use for this purpose should be prohibited by law.

Germany and France have long been engaged in briquetting by pressure without the use of a binder. The slack is subjected to a pressure of roughly 1000 atmosphere and the temperature increase obtained as a result of this pressure is sufficient to partly soften the low melting bitumens of the coal which give a binding action to the coal particles. Bituminous coals containing hydrogen over 5 per cent are strongly caking and therefore lend themselves easily to briquetting with this process. The Tilamenstone briquetting plant near Dover is capable of manufacturing 20 tons of coal briquettes per hour and most of these briquettes are used for Locomotive firing

Price Structure of Coal :—All seams in the collieries situated in Bihar and Bengal are graded by the Coal Commissioner's Department from analysis of samples taken at the mine. Each grade has a pitmouth price fixed by the Government. The collieries do not check the quality of coal wagons despatched although the equipment required for the work is neither expensive nor difficult to obtain. It is therefore very necessary that the consumers must have the coal tested on receipt. By referring to the existing rates of coal we find that the decrease in price per ton of coal from Grade I to Grade II and from Grade II to Grade III A and III B for the Jharia seams is only taken at six annas per ton. From this it is apparent that the price per ton of coal is not commensurate with its quality on the basis of fuel value since the price difference between the various grades is too small. In other words the best grade coals have been devaluated and inferior grades have been over-valuated with the result that the suppliers have no incentive to supply better grades as they do not stand to gain financially by supplying superior grade of coal. Moreover, it is probably due to this low margin of difference between the prices of various grades that almost all the consumers ask for best grades although it may not be actually necessary for their use.

By referring to specifications of other countries we find that the price per ton of coal is reduced by 2% for every rise of 1% in the Ash Content of Coal. This would mean that the coal with 50% Ash would have zero or no value. The coals of India unfortunately are difficult to clean, whether by hand picking or by washing as the foreign matter is very finely dispersed throughout the body of the coal.

The price in Rupees per ton of coal is generally governed by commercial, political, international or other considerations and to avoid these issues we should choose a scientific scale of price point varying from 0—100. For a Coal of zero ash and zero moisture the price is taken as 100 point per ton. In European countries a coal with 50% Ash is given zero value but in India where the ash contents are generally of the higher order and are difficult to clean, a coal with 66.6% Ash would be considered useless and given zero value. The formula for price point may be given as follows: –

$P = 100 - M - 1.5A$ where P is the price point, M is moisture per cent and A is the Ash per cent.

The practical applicability of the above formula to the existing grades would be of interest. It is necessary to fix the value of 100 price point and its present value may be taken as Rs. 30/-. The theoretical coal with zero Ash and zero Moisture would be valued at Rs. 30 per ton.

If a coal sample for example has 16% ash and 2% moisture its price point would be:—

$P = 100 - M - 1.5A = 100 - 2 - 24 = 74$. And the price of a ton of this coal would therefore be:—

$$\frac{74 \times 30}{100},$$ that is equal to Rs. 22.2.

According to this the following price structure for various grades of coal has been calculated.

TABLE II

SUGGESTED PRICE STRUCTURE OF VARIOUS GRADES OF COAL

Grade	Ash + Moisture percent	Price (100-M-1.5A) Rs.
Selected A	14+2	23.1
" B	16+2	22.2
Grade I	20+1	20.7
Grade II	24+1	18.9
Grade IIIA	28+1	17.1
Grade IIIB	34+1	14.4

Indian Railways always insist upon getting coals to standard grades but in large number of cases it has been noticed that when check analysis are carried out the consignment are generally of much poorer quality. It may be pointed out here that in cases of coals having 33% Ash, every third wagon of this coal would be engaged in carrying useless material thus locking up a large wagon capacity of the country. In the interest of economy of transport as well as for the efficient utilization of fuel in the locomotive, it is suggested that a very deterrent action in the form of penalty should be introduced in the specifications so that the Colliery Owners may be forced to have their coal supplies tested and analysed before despatch to the consumers. In the past for want of suitable testing equipment at the collieries they have not been able to ascertain the quality of the coal with the result that the useless insert matter is not only carried by the railway wagons but the railway operations suffer considerably on this account. It is very essential that Indian Railways should have proper coal testing centres where quick and ready methods of testing should be applied for checking the quality of the coals before acceptance.

BOILER WATERS FOR LOCOMOTIVES

An average locomotive using an average quality of coal, evaporates about 1 gallon of water per sq. ft. of the heating surface area. In the case of water having a hardness of 14°, it will produce 2 lbs. of scale per 1000 gallons of water evaporated. This scale in a boiler acts as an insulator and therefore a considerably large number of heat units have to be used to get the necessary steam pressure in the boiler. In some cases due to overheating this results in bursting or bulging of boiler tubes. In addition to this heat loss which is incurred due to the deposition of scale, the other troubles generally encountered are those of corrosion, priming and caustic embrittlement. To inhibit corrosion in the boiler the water is generally reconditioned to give certain amount of free alkalinity. As regards priming, some authorities maintain that it is caused by the concentration of sodium salts in the boiler, whereas others are of the opinion that it is due to the small particles of solid matter left in suspension. The above three main troubles i.e. scaling, corrosion and priming are generally met with in all boiler waters and therefore Locomotive Engineers always resort to have their boiler feed waters suitably softened and treated before using them for boiler purposes.

While water softening has made much progress in foreign countries, as will be seen from the facts which are reproduced further in this paper, it is only in its infancy in India. Even Railways that consume large quantities of water per day have only recently begun to appreciate the immense possibilities of savings in running costs with a properly softened water. B.B. & C.I. Rly. was the first Railway in India to start water softening and their plant at Abu Road was installed as early as 1911. The success of this softener, which showed a saving of Rs. 38,000 per year led to the adoption of water softening schemes on a number of their stations. Since then, other Railways in India also began to appreciate the importance of softened water and several plants were started on different Railways. The enclosed table shows the location of water softening plants on Indian Railways in operation along with type and capacity of the plant in each case. If will be observed that no railway has got any systematic installation of water softening plants whereby their engines could run entirely on softened waters. The result has been that a mixture of untreated and softened water is being used all over. Even under these unfavourable conditions the experience of every railway has been encouraging due to savings in running and repair costs, and attempts are now being made to multiply softening plants on many railways so that maximum benefit could be derived by running engines entirely on softened water. It is surprising to note that in a vast country like India with an extensive steam locomotive traffic, there are not more than 70 softening and treatment plants in operation on all the Indian Railways. The total water consumption for locomotive use on Indian Railways comes to about 12 thousand million gallons per year whereas the total softened quantity is only about one thousand million gallons.

In 1944 Inglis-Appleton Mission drew the attention of the Indian Railways to some of the benefits to be derived from the softening of Locomotive Feed Waters and made the following comments on this subject:—

> "Generally speaking the water supply for Locomotives throughout the country is of poor quality and entails very frequent washing out of boilers. The distance runs between washouts varies from 500 to 800 miles, few engines are able to go beyond those figures.
>
> We understand the question of water softening has been given much consideration but so far as we can learn it has only been carried to a conclusion on two Railways. The experience on those Railways has been so favourable that they propose to instal many more softening plants. Before water softening was introduced, all engines required washout every 500 to 800 miles on an average but after plants had been in operation engines now run distances of from 3,600 to 8,000 miles, a vast improvement. As an ordinary washout occupies a period of 8 to 9 hours, the saving in time, labour and the increased availability of the locomotive must be evident.
>
> It is strongly recommended that water treatment should be further investigated and pressed to a definite conclusion in order to obviate the necessity for such frequent boiler washings with the consequent removals of engines effected from the availability list. Under the stress of heavy traffic demands this is a serious handicap apart altogether from the cost, which on a year's working must be very large and the saving which would accrue would pay for many softening plants."

Water Softening Plants and Wayside Treatment Systems in Operation on Indian Railways

WATER SOFTENING PLANTS AND WAYSIDE TREATMENT SYSTEM IN OPERATION ON INDIAN RAILWAYS

B.B. & C.I. RLY.			JODHPUR RLY.			JAMNAGAR (Contd).			B.N. (Contd).		
STATION	Type	Capacity	STATION			STATION	Type	Capacity	STATION	Type	Capacity
PALGHAR	L.S.	6.0	GIDHRA ROAD	LS.		SASANGIR	L.S.	4.0	HOWRAH	L.S.	6.0
DHANU ROAD	”	”	BARMER	”		VISAVADAR	”	4.0	MACHABA	B.E.	4.0
SURAT	”	”	BALOTRA	”		G.I.P. RLY.			BAURIA	”	4.0
BROACH	”	”	MARWAR PALI	”		POONA	W.T.		BALASORE	W.T.	
BARODA (Yard)	”	10.0	MARWAR JN.	”		URULI	L.S.	6.0	JENAPUR	”	
BARODA (Station)	”	6.0	MERTA ROAD	”		DHOND	”	6.0	CUTTACK	”	
ANAND	”	6.0	NAGAUR	”		POMALVADI	B.E.		KURDA ROAD	”	
NADIAD	”	6.0	BIKANER RLY.			BHALAVNI	L.S.	6.0	KALAPUR GT.	”	
KANKARIA	”	6.0	BIKANER	L.S.	4.0	KURDWADI	”	6.0	RANBHA	”	
VIRAMGAM	”	6.0	HANUMANGARH	”	4.0	MAHOL	”	6.0	CHATRAPUR	”	
GODHRA	”	6.0	MAHAJAN	”	4.0	M.S.M. RLY.			GANJAM	”	
SEVALIA	”	6.0	DHIRERA	”	4.0	GADAG	L.S.	4.0	PALASA	”	
SURENDRANAGAR	”	6.0	SURPURA	”	4.0	BOWRINGPET	L.S.	4.0	KOTABOMMALI	”	
PALANPUR	”	1.4	CHURU	WT		RAJAHMUNDARY	”	4.p	DUSI	”	
ABU ROAD	”	3.5	JAMNAGAR RLY.			WALTAIR	”	6.0	SANTRAGACHI	B.E.	4.0
MORI BERA	”	1.4	VEREVAL	LS.	4.0	B.N. RLY.					
NEEMUCH	”	1.4	SHAPUR	”	4.0	VIZIANAGRAM	L.S.	6.0			
MHOW	”	2.8	JUNAGADH	”	1.4	BHOJODIH	”	6.0			
BANDIKUI	”	1.4	PARACHI	”	4.0	BHADRAK	”	6.0			
MEHSANA	”	2.8	DELVAIA	”	4.0	SHALIMAR	”	6.0			

NOTE

L.S.=Lime soda Type Plants.
B.E.=Base Exchange
W.T.=Wayside Treatment

Capacities of Plants given in Thousand Thousands of Gallons per hour.

As a result of this recommendation, the Railway Board appointed an expert committee consisting of Mr. J. S. Hancock of L.M. & S. Railway and the Author to investigate and report on the subject of water softening on Indian Railways. The report of this Committee was submitted to the Railway Board in June 1945, and has since been receiving the active consideration of the Railway Board.

WATER SOFTENING IN FOREIGN COUNTRIES

U.S.A.:—In U.S.A. water treatment has made a remarkable record of savings during war years. In 1944, according to the 33rd Annual Report of the Director of the Bureau of Locomotive Inspection, extensions were granted to the time of removal of flues to 1302 locomotives. This alone is sufficiently indicative of the effect of water treatment, for no such extensions could have been granted if the flues had not been clean.

According to the report of Mr. C. R. Knowles, Superintendent Water Service of the Illionois Central System, published in the Railway Age of 1943, the Life of Flues and Tubes in the 60 locomotives under observation was increased from 5 to 15 years. The life of fire boxes was doubled i.e. from 10 to 20 years. The combined savings each year in the cost of flue tubes and fire box sheets was enormous, in addition to savings in critical material and skilled labour that was effected through water treatment programme. According to the latest figures, locomotives in U.S.A. consume about 437,000 million gallons of water each year. It is estimated that 44% of this water is being treated in full or in part, thus removing or making harmless more than 220 million lbs. of scale annually, saving about 30 million dollars per year. The same source states that the treatment is being used at 5000 watering stations and that there are still 8250 additional stations at which water treatment was expected to be installed before long.

According to the Report of Master Boiler Makers' Association U.S.A., it is a matter of simple calculations to prove that if the work produced per month per locomotive during World War II had been the same as in the first World War, U.S.A. should have needed 80,000 locomotives, an increase of some 40,000 units over their actual inventory. Had it been necessary to provide this additional power it would have cost U.S.A. several Billion Dollars, taking several years time to build, and the manpower that would have been used for making these locomotives could not have been used to make battleships, tanks, air-craft and all the other tools of modern warfare.

U.K.:—In 1930, the Locomotive Water & Fuel Committee of L.M. & S.Rly. while investigating the effect of hard feed water on locomotive boiler maintenance found that during the year 1927-28 workshop repair costs for the 45 compound engine boilers stationed in Scotland were lower by 62 £. per engine per annum as compared with engines stationed in Midland Division in England. The Committee also found that the Running Shed maintenance cost of these boilers showed a difference of 35 £. per engine per annum in favour of Scotland. From experimental evidence it was concluded that the Fuel Consumption of the Scottish Engines was 2½% less than the English engines. These differences were found to be due to the Locomotive Feed Water supplies in Scotland being Soft, whereas feed waters in England were generally hard and often corrosive.

As a result of this investigation it was decided by L.M.S. Rly. to erect 28 water softening plants in England on the Euston-Carlisle and St. Pancras-Carlisle main lines. The first plant was brought into service in May 1932 and 27 plants were in operation by January 1933. In consequence of the improvement in boiler conditions which was being noticed by the introduction of these plants, 22 new water softening plants in the Derby-Bristol, Crewe-Holyhead and Yorkshire-Lancashire were installed in May 1933. By the end of 1944, they had completed 175 plants which had cost them about 800,000 £. This will give them approximately 90% of treated water. This Railway has only one type of plant i.e. Lime-Soda, but they are experimenting with Base Exchange Plants at some of their stations.

The following points may be summarised from the experience of water softening plants on L.M.S. Rly.

(1) Ratio of softened to unsoftened water governs savings and that maximum benefit can only result from the use of 100% softened water, even a small percentage of crude water causing a serious decline.

(2) Water with less than 10° of Hardness should be treated with Soda-Ash and Tannin but waters with 10° or more of hardness should be properly softened.

(3) All the waters whether softened or treated must contain excess soda-alkalinity. This will prevent corrosion of steel but to avoid corrosion of copper, tannin must be added.

(4) All water softening plants should be of the same type i.e. either Base Exchange or Lime Soda and not mixed. They should be simple to operate and easy to control.

South America:—In 1944 South American Railways had 300 Base Exchange Plants in operation extending over nine railways. These plants soften approximately 12½ million gallons of water per day, each plant being capable of treating 42,000 gallons of water per day. The approximate cost of each of these plants is about 1000 £.

As regards Priming, South American Railways have reached the concentration of 5320 g.p.g. without any signs of priming but they generally maintain an average figure of 730 g.p.g. by blowing down.

Taking the case of one Railway alone i.e. British American Pacific, the savings obtained during one year ending June 1939 as given by the Chief Mechanical Engineer of that Railway comes to 23591 £. against a capital cost of 25000 £. The general comments of the Chief Mechanical Engineer are worth quoting, "Softened Water Service continues to prove its value, boilers remain clean, difficulties due to priming are almost unknown and corrosion is being steadily eliminated. The Railway Chemical Engineers' Report sums up the situation in these words: "In general it can be stated that the softened water service has again given a good account of itself and by enabling boilers to be kept clean has assisted by materially obtaining the maximum energy from inferior fuels that have to be used."

GREATER AVAILABILITY OF LOCOMOTIVES AS A RESULT OF SOFTENING

The greater availability of steam locomotives, by using softened water cannot be easily evalued in terms of cash.

In addition to the savings in boiler repair costs which can be easily ascertained, there is the additional availability as a direct result of the time saved that would normally be spent in these repairs.

Though figures of increased fuel economy due to the greater heat transfer in a cleaner, and scale free heating surface of the boiler is shown sometimes at 2 to 4%, the actual economy is difficult to determine. What is certain and easily computed is the number of engine hours that are wasted in washing out.

Very few plant manufacturers, chemical engineers, or others have illustrated in figures, the actual availability of steam locomotives that can be achieved by softening the feed water. In this respect the Author has carried out very exhaustive investigations with a view to collect data extending over a period of years. On the B.B. & C.I. Railway's Metre Gauge System in particular, all five districts have been dealt with in detail.

For instance, taking a particular shed like Abu Road having a total number of 47 engines, the total number of washouts absolutely essential comes to 5640 per annum, i.e. one washout per engine every three days. Under the proposed economy scheme of the author each engine should be given a washout every 15 days thereby saving the time occupied by 8 washouts, equivalent to a saving of about 80 hours per Loco. There are 94 engines in the Abu District which require 11,280 washouts per year, occupying a total of 1,12,800 hours. The number of hours saved by the reduced washout programme would be 90,240. If all these hours could be utilized it would be the equivalent of 10 engines working continuously for 24 hours a day throughout the year. Likewise, all other districts have been dealt with by the author in detail and a grand total of 509,040 hours saved which is theoretically equivalent to 56 engines working continuously for 24 hours a day throughout the year.

Everyone realises that it is not possible to utilize all these hours, but each Mechanical Engineer should be able to visualize the economy that can be effected in locomotive working on account of this extra-availability and the resulting savings in labour and time. In certain cases a readjustment in a link and keeping particular locomotives in longer continued service will reduce the number required, or the transfer of the extra power to another link or section to relieve the pressure would result in improved efficiency.

Good proof of increased availability is evident from the actual experience of some South American Railways. Incidentally, softening has been practised on those railways to a far greater extent than any other country in the world, and it is extremely necessary for a country like India which is very short of Locomotive power at present to make as intensive a use of our existing stock of Locomotives as possible by providing properly softened and conditioned water for their use.

USE OF METALS ON RAILWAYS

The next important material used on the Railwaysis that of Metals, which during the year 1943 amounted to a sum of Rs. 26 million. Permanent Way materials, *i.e.*, rails, fishplates and metal sleepers amounted to seven million rupees. If we look to the railway system as a whole, we can easily see for ourselves what a large amount or metal is involved in the construction of locomotives and other rolling stock and on the track on which they run. These rails of course wear out due to constant use and corrosion and have to be replaced say after every 35 years.

The total quantity of steel used in the railway track on Indian Railways approximately amounts to 50 lakhs tons. In U.S.A. a replacement figure of 4 to 5% or 8 to 10 tons of steel rails per mile of track per annum has been arrived at as a result of extensive experiments. According to this estimate, the steel required for annual replacement of our railway track in India would come to approximately 2½ lakhs tons. This is evidently a high figure and our steel producing capacity in this country cannot meet this demand. In the case of some European countries only 2% replacement figure is computed for this purpose and even according to this figure Indian railways would still require one lakh tons of steel for rail replacement every year. It would be of interest to note that Railroads in U.S.A. consume 2 million tons of Steel every year for replacement of their railway track.

According to the figures that have been collected from some of the continental railways, I find that as a result of heat treatment 43 million tons of traffic caused a wear of one sq. centimeter in cross section as compared with 14 million tons for the same amount of wear before treatment. I recommend that special Medium Manganese steel should be used extensively.

We have over 85 million sleepers in the railway track in this country and taking an average accepted replacement figure of 4%, we would require over 3 million sleepers a year. In U.S.A. they use a replacement figure of 6.5%, and replace 50 million sleepers every year in a track having 750 million sleepers. In the case of wooden sleeper Indian Railways should have a proper creosoting plant to extend their life.

Railways spend a very large sum of money in the upkeep of the Permanent Way. It has been stated that 60 per cent of the total cost spent on Permanent Way is due to the joint maintenance and the rest in its upkeep. This maintenance cost could be considerably reduced by welding of rails. The use of these welded rails on main lines, sidings, tunnels and underground lines has extensively increased throughout the world particularly in U.S.A. One of the most important uses to which welding could be applied is in the reconditioning of the crossings. It is estimated that by this means the life of a crossing is extended by 50 to 70 per cent at less than 25 per cent of the cost of new crossings. According to the Wedgewood Enquiry Committee's Report, short length rails varying from 21 to 24 ft. which are generally regarded as scrap were welded on to 69 and 72 ft. lengths and safely used in South Africa. This subject involving the reduction in the number of rail joints is a very important subject of research on Indian Railways and has been very strongly emphasized by the Wedgewood Commission.

According to the calculations of the American Engineering Association, the prevention of a rail from expending or contracting causes an internal stress of 195lbs. per sq. inch for each 1°F change in temperature. Thus a change in temperature of 100°F would create an internal stress in the rail of 19, 500lb. or 8.75 Tons per sq. inch.

To minimise these high internal stresses, it is customary to lay long rails at the mean average annual temperature, and thus reduce the tendency of the rail to buckle, if the fastenings should become weakened. One of the great difficulties with long rails, apart from the practical limitations provided by transport, is that opening up of the track can be done only at a approximately the same temperature as that at which the rail was laid. This places severe limitations on a maintenance programme and can become even more serious in the event of a rail fracture when it is necessary to remove the defective section. It is for this reason, undoubtedly, that use of very long welded rails has not spread more rapidly.

The longest stretch of continuous welded rails in U.S.A. at present is 12782 ft. There are in U.S.A at least ten stretches of continuous rails each more than a mile in length. Previously Thermit process was extensively used for welding but it has been replaced at present by Flash-butt welding process which is giving very satisfactory joints.

It cannot be claimed for a Welded rail joint, no mater by what process it has been formed, that it has all the characteristics similar to or as good as virgin rails. This is almost self-evident when one considers the rough heat treatment which the adjacent metal must undergo during the welding operations. It is of interest to note in this connection that when a welded joint is tested to destruction, either by slow bending or by a "Tup" test, fracture does not usually occur in the plane of the weld but in a plane in one or other of the parent rails close to the weld where the drastic heating and cooling has had the most serious effect on the structure of the steel.

The smoother riding qualities of the track, with welded joints, provide greater comfort to the travelling public. This is only one advantage which may be claimed for it, and which is of general interest. There are many others of a technical-cum-economic nature, which are enumerated below :—

(i) With the ordinary fish plated joints, the rail develope "end batter" and tend to "hog". This shortens the useful life of a rail. In a welded rail, this is absent.

(ii) When a locomotive passes over a bridge , with rail joints over girders, the "rail joint effect" as it is termed, causes an increased loading on the bridge, which consequently has to be much stronger and this requires the use of more steel. The absence of rail joints over a bridge girder, therefore means a saving in steel.

(iii) On Sections of the line which are electrified both for traction and signalling, track Bonding" is necessary at joints. This is not only eliminated where the joints are welded but the continuous welded rail is also better.

METALS IN WORKSHOPS

Now coming to the workshops where all rolling stock is manufactured and repaired, we notice that every process involves the use of metals in some form or the other. Some parts are cast in the Foundries with which practically every workshop is equipped though very few of them are designed on modern lines and operated scientifically.

Indian Railways are the largest users of Pig Iron for their foundries and they use about 1.9 lakh tons every years. In terms of outturn it comes to about one lakh tons of finished castings.

As a result of research conducted at Ajmer from the funds provided by the Railway Board, it was possible during the war to produce High Duty Cast Iron comparable in physical properties to that of Meehanite—a patented alloy. However, a great deal needs to be done to standardize all the conditions which will enable us to produce our castings of uniform and standard quality. Some of the railways will not be able to avail of this research unless their furnaces are remodelled on proper scientific lines.

As regards non-ferrous foundries, we find that the melting technique in most of the Railways is far from being modern. From the information collected recently I find that Indian Railways use Non-Ferrous metals worth over Rs. 85 Lakhs every year. I think Indian Railways are the largest buyers and dealers of non-ferrous metals in this country, but it is surprising to know that no metallurgical research worth mentioning is being done either to improve the quality of these various alloys, or to develope cheaper and new ones. Indian Railways at present have in their custody non-ferrous scrap weighing hundreds of tons and excepting its disposal to merchants, railways are not in a position to recondition this scrap to their own advantage for want of proper scientific equipment for refining etc.

I would strongly advocate that special experimental work must be undertaken to refine the various grades of scrap available for re-use on the Railways.

India is very deficient in all non-ferrous metals and this is particularly so in the case of Tin which is an expensive metal but is considerably used in various alloys which are manufactured for the railway rolling stock. During these days when the conservation of Tin has become a dire necessity, attempts should be made to develop Tin substitutes for Tin bearing alloys in order to relieve presure on the demand for this metal. Several contributions have been made in this direction by the British Non-Ferrous Research Association for manufacturing alloys free from Tin as substitutes for admiralty Gun Metals and other Bronzes. As a result of research work done in this field in U.K. and U.S.A., Tin-free Bronzes which are known by the name of P.M.G. and Everdur Alloys have been developecd successfully. During the war when there was acute shortage of Tin, the problem of making similar Tin-free alloys in this country for use in the Railways was entrusted to the Author and as a result of our investigations we were able to produce Tin-free alloys for the first time in this country. These alloys were tested under various conditions in the Laboratory and were found to give very satisfactory results as compared with Tin Bronzes. Recently as a measure of national economy the Railway Board have again taken up this question and we soon hope to put these alloys in commercial use which would show a very great saving towards the cost of non-ferrous metals.

USE OF LIGHT METALS

The subject of reduction in weight of Rolling Stock was further discussed at the International Railway Congress Association held in Switzerland in 1947, and much useful work has been done in this direction uptil now.

In 1933 it was agreed by the International Railway Congress that great deal of reduction could be made by employing various welding processes for forming assemblies and using light alloys for certain internal fittings not subjected to any appreciable strain. Since then we have witnessed a gradual development in design tending towards a general reduction in dead weight without in any way diminishing the safety or comfort of passengers. The Netherland Railways have reported a saving of 5 tons in the weight of their coaches by employing electric welding in place of rivetting.

The Association sent out detailed questionnaire to 42 Railway Administrations of the world, out of which only 27 replied.

In every country it is the practice to compare the weights of vehicles by taking an essential basis the weight per seat or per passenger capable of being carried. The dead weight varies according to the type of vehicles. By using light metal streamlined body, it was experimented in France that the total weight reduction per seat achieved in comparison with all steel stock which was 970 lbs., the light weight metal used gave the dead weight per seat of 606 lbs., showing a saving of 37.5%.

The French National Railways consider that unless we use special steel or light-alloys in constructing the principal parts of the underframe and the body, it is not possible to bring down the dead weight below 30 tons. The Swiss Federal Railways fix the limiting figure of 25 tons for their light weight steel coaches.

It seems clear from the above that the French coaches and the light weight Swiss vehicles represent the lightest type of stock that can be considered practicable in the existing state of technical development without incurring any diminuation in the standards of comfort and safety.

The Michilin Company have recommended the use of pneumatic tyres for vehicles with a dead weight of 16-18 tons capable of being constructed in stainless steel or ordinary steel and light alloys. The use of pneumatic tyres puts the question of comfort and the stresses effecting the under frame and body under an entirely different angle from that involved with vehicles on two hard surfaces in contact. This is a very suitable field of investigaiton in which future designs will tend to develop in their endeavour to obtain further saving in weight.

There are number of pneumatic tyred rail coaches in use on the continent. The latest is a 400 H.P. composite train mounted on pneumatic tyres running on standard guage line. The maximum speed of the train is 80 miles per hour and it weighs 19 short tons and carries 136 passengers. As in ordinary Motor Car tyres, the pneumatic rail tyre is filled with air, the pressure used being 114—130 lbs. per sq. inch.

Regarding the effect of weight reduction on cost of haulage, the Italian State Rlys. admit that these costs fall by an amount equal to a percentage of weight reduction achieved multiplied by a coefficient varying between 0.25 and 0.35, the first figure relating to steam, the second to electric trains. The French National Railways consider that for a 15-coach train of 32-34 tons tare per coach, the average reduction in dead weight of 180 tons or 35% will cut running cost by 10% *i.e.*, by about a third of the percentage of weight reduction.

Weight reduction also offers certain definite advantages not easily expressed in figures :—

(1) the appreciable saving of material for building the vehicle,

(2) reduction in track maintenance weight cost as a result of smaller axle loads,

(3) The possibility of using less powerful and lighter engines thereby causing less wear and tear on the Permanent Way.

In this respect it is interesting to note that Indian Railways have recently designed a new coach which weighs only 65% of the prewar times. The new coach is 70ft. long and 11ft. 8 in. wide as compared with 68ft. and 10ft. respectively of the old design. The weight of an average fully loaded train will be 360 tons as against the prewar figure of 550 tons.

LUBRICATING OILS

Indian Railways use about three million gallons of lubricating oils and greases per year costing over Rupees Two Crore and Thirty-two lakhs. Their requirements vary from Spindle Oil to Petroleum Jelley and Hard

Greases. There are more than fifty items of these Lubricating Oils for which different specifications have been laid down. Most of these oils after use are thrown away to waste for want of suitable refining equipment. It was suggested in my address before the Institution of Engineers in 1946 that every railway should endeavour to refine its own used oils as far as possible and in this respect N.W.Rly. took an initiative and erected a plant for their use.. This plant was designed to handle about 100 tons of used oil a year which roughly gave a saving of Rs. 29,000. I suggest that similar oil reconditioning plants should be introduced on other Railways as it would be a source, of great saving to them.

I will not go into the subject of hot boxes which are sometimes caused by scanty lubrication as it is a very exhaustive subject by itself, but in connection with the type of lubrication I would strongly point out that solidifed oils have many points in favour of their use, such as, less losses through leakages and splashings which happen in the case of mobile liquids. This loss if not duly replenished would cause hot box for lack of lubrication which will not happen in the case of solidified oils.

The latest development in this field is to have oilless bearing in which the oil is kept absorbed in the spongy pores of the bearing metal which is prepared from metal powders which have been compacted and sintered according to the desired porosity. In order to utilise the lubricating properties of graphite, its fine particles can be mixed with copper, tin, lead and other non ferrous ingredients for the manufacture of porous bearings. There are vast possibilities of powder metallurgy on the railways whereby metals of different melting points can be incorporated into one body. Further information on the subject of Powder Metallurgy can be had from the Author's article published in the Journal of Scientific & Industrial Research.

PAINTS AND VARNISHES

To avoid corrosion and to increase the life of the Railway Rolling Stock and other structures, painting of their surfaces is very essential. Indian Railways use all kinds of paints varnishes, enamels etc. for this purpose the total cost of which amounts to over Rs. 80 lakhs per year. Indian Railways should make full use of the various indigenous materials which are readily avialable in this country in preference to foreign imports.

It has been noticed that practically most of the senior supervisory staff of the Paints & Varnish Department of various railways have no scientific background or technical training of any kind. Their work is more or less of a routine nature and they are not capable of understanding the various operations involved in this work. In the interset of efficiency it is highly necessary that the supervisory staff should have some training in the chemical physical and practical aspects of this industry on which such a huge expenditure is incurred every year. I have included the training course in paints and varnish technology under the workshop courses of study which have been described further in my address under the subject of "Scientific Manpower Reserve", but I would suggest that Indian Railways should have an up-to-date paint and varnish laboratory similar to the one on the L.M. & S. Railway. This research laboratory should have a manufacturing centre attached to it, from which all the requirements of Indian Railways would be easily met and the research laboratory would be able to pay for itself in this way. A similar suggestion has also been made by Paints & Varnishes Panel of the Department of Planning & Development of the Government of India and I think it is highly essential that this work should be taken in hand as early as possible as it would lead to both efficiency and economy.

I have recently learnt from the study of scientific research report of British Railways that they have developed a process whereby one complete coach was completed within two days instead of ten days taken by us on Indian railways. It has been well established that the drying property of the paint film is largely dependent upon the quality of the pigments used. In cases where the pigments have high oil absorptive power, the paints made from them will not easily dry unless excess of thinners are added and consequently large number of coats will be required to impart proper opacity to the surface. This is probably the reason why our coaches and wagons on Indian railways have to be given more coats as compared with British practice. The increased production drive of our country demands that outturn of our coaches from the workshops should be as quick and speedy as possible and for this purpose comprehensive scientific research is necessary.

LOCOMOTIVES AND COACHING STOCK

In meeting the ever-expanding modern needs of an efficient system of Railway Transport, Power plays the most important part. It is to be regretted that in designing and planning this system of transport for India no systematic efforts to meet its future needs were given proper consideration. The Indian Railways were importing complete locomotives built in foreign countries as well as the spare parts required for their maintenance. If at the initial stage steps had been taken to put up the locomotive manufacturing industry in this country, India would have by now made tremendous progress in industrial field. The authorised stock of steam locomotives on Indian Railways on 31st March, 1944 was 5285 B.G., 2456 M.G. and 532 N.G. locomotives, for the purchase of which crores of rupees had to be spent outside the country. Only in Jamalpur (E.I.Rly) and Ajmer (BB&CI. Rly.) workshops steps were taken to build Locomotives and Boilers as early as 1919. Upto 1923 Jamalpur workshops manufactured 214 complete locomotives and 103 additional boilers while uptil 1941, BB & CI.Rly. workshops at Ajmer built 444 locomotives complete and 339 additional boilers. This shows that the requisite intelligence and technical experience to run this industry was not lacking in this country.

During the first great war, when the imports were severely restricted, the Govermement of India felt the necessity of making Indian Railways independent of foreign imports and outside sources so far as the supply of materials for locomotive manufacture was concerned.

Since then persistent representations were made by the public to start this industry in this country. In 1918 Government of India issued a communique guaranteeing purchase of 2500 B.G. and 50 M.G. wagons in India annually for a period of 10 years and also 160 locomotives and 160 additional boilers during each of the years 1923 & 1924, and 400 Locomotives and 400 additional boilers every year after that. The Peninsular Locomotive Company with a capital of Rs. 40 Lakhs was started to supply these but went out of business without manufacturing a single locomotive for want of Government protection. In 1931 it was decided by the Railway Board that the Government of India should itself run this industry, but the period from 1931-1940 was wasted in schemes and manipulations and no concrete action was taken by the Government of India. With the increasing cost of foreign locomotives, Railway Board placed Messrs. J. Humphry and K. C. Srinivasan on Special Duty to investigate this problem in detail but the recommendations made by this Committee could not be implemented because of the exigencies of the second World War.

As a result of non-availability of replacement and spare parts during the second World War and the subsequent partition of the country, Railway System had to work under a very heavy strain which has effected its power position very adversely. Moreover, out of about 7000 locomotives, 1470 have reached or are about to reach the condemning age very shortly. These will ultimately be scrapped due to prohibitive maintenance cost. Moreover, multiplicity of the types of locomotives renders the maintenance difficult as the spare parts are not interchangeable.

Intensive efforts are now being made to improve the power position of the railways consistent with the growing needs of the country. To meet immediate needs, orders have been placed abroad for 863 locomotives in addition to 10 B. G. locomotives under construction at B. B. & C. I. Rly. Workshops at Ajmer. Out of these U. S. A. has got an order for 303, Canada 350, U. K. 190 and France 23. These consist of 640 B. G., 203 M. G. and 20 N. G. Out of these a large number has already been received and the remaining are expected soon. At the same time Rs. 14 Crore Chitranjan Project at Mihijam for the complete manufacture and production of locomotives in this country is proceeding rapidly. National interest demands that this country must be self contained in respect of key industries like Locomotive manufacture which is of vital importance during national emergency. It is expected that the first Locomotive will come out of these workshops by the end of 1950.

In this connection it would be interesting to have some idea about the quantity of different metals required for the manufacture of a complete locomotive (say XE type) with boiler and tender :—

	Tons
Cast Steel.	25
Cast Iron.	13
Mild Steel.	77
Class IV Steel.	25
Gun Metal, Phosphor Bronze, Brazing Metal, Copper etc.	2
Copper Rods, Fire-box Plates	3
Copper Rivets.	1
White Metal.	¼

AIR CONDITIONING OF RAILWAY COACHES

Air-conditioning is being rapidly adopted on Indian Railways. There are three main types of plants employed :—

(1) Electro-mechanical as used on GIP & EIR,

(2) Cabinet System as used on two GIP coaches from Bombay to Madras (as an experiment).

(3) Ice-activated System as used on BB & CI.Rly.

In the Diesel Mechanical coaches built for the Nizam State Rly., the air-conditioning system provides the passengers with constantly circulating dust free air at the correct temperature and humidity for personal comforts, the desired temperature being controlled by a series of thermostats. Fresh air is mixed with a proportion of recirculated air and is delivered from the evaporative unit through downwardly discharging ducts in the ceiling of the compartment. The refrigerant used is freon and the equipment is controlled by a panel in one of the two driving compartments. The Cabinet system is in fact an electro-mechanical system which is adopted to suit the unit principle and in this case it is not necessary to provide roof ducts. From the study of the different methods of air-conditioning on different Indian railways it has been estimated that the cabinet system works out to be the cheapest of the three methods, It may be said in passing that in the ice-activated coaches a large quantity of ice is required and unless a special ice plant is erected for this purpose as has been done at Shamgarh on the BB & CI.Rly. it is very difficult to work on this system. While making these calculations for air conditioning of coaches we take into consideration the fact that 25 cu. ft. of fresh air per minute per passenger is provided.

ELECTRIFICATION OF RAILWAYS

At present we have only 236 route miles of Indian railways which has been electrified. The electrification of a further 1500 miles track *i.e.* from Bombay to Ahmedabad and Howrah to Moghalsarai (via Grand Chord) at an estimated cost of Rs. 62 Crores is at present under active consideration of the Government of India. If this scheme is taken up, there will be a saving of 600,000 tons of of coal of which 40% would be of high grade quality.

The electric locomotive has on an average an efficiency of 85% and the overall efficiency of electric traction system using thermal power averages from 14 to 17% which is roughly 3-4 times that of steam traction system. This accounts for the reduced coal consumption which it would be possible to economise by the electrification of the Railways.

At lower Traffic Densities, Steam Traction works out cheaper than electrictraction, the reason being that electric traction has the initial burden of high depreciation and interest charges on the cost of Power Station, Transmission and distributing equipment.

The following are operating expenses of steam locomotive as compared with electric locomotive.

	SteamLocomotive	Electric Locomotive
	(Cost per engine	mile in Rupees)
Repair & Maintenance	0.70	0.4
Lubrication	0.06	.01
Water	0.08	Nil
Total	0.84	0.41

RECENT IMPROVEMENTS IS LOCOMOTIVE OPERATION:

Stream Lining.—From experiments done at Pennsylvania Railroad Research Laboratory it has been estimated that at a speed of 100 miles per hour, with a side wind of 33 miles per hour, streamlining showed a saving of 1200 H.P. as compared to normal train. At 80 miles per hour a saving of 500 H.P. was shown. According to Chrysler Company's experiments, the air resistance represents 40% of the total power needed to drive a car. At 60 miles per hour by using stream lining it is possible to save 33% of the power. The above facts clearly signify that stream lining can be a source of very great saving in the coal consumption of our stream power locomotives.

Surface Hardening:—In addition to nitriding and case-carburising processes for hardening metal surfaces, which are used to resist wear of some of the locomotive parts recent metallurgical advances have shown that by silicon-impregnation of steel, it makes the steel parts resistant to corrosion, heat and wear. By this process the metal is subjected to Silicon Carbide and Chlorine at a temperature of 930 to 1010°C. Ferro-Silicon or mixture of Ferro-Silicon & Silicon-Carbide can also be used. The surface is impregnated with silicon upto 14% in the case which ranges from .005 inch to 0.1 inch depending on the time of exposure. This is the cheapest method of imparting valuable properties to steel and is being widely used on foreign railways.

Condenser Locomotive:—Soviet Russia has produced new and improved types of condenser locomotives which can run a thousand miles without taking water. The condensing installation of this type of Loco. converts the steam discharged by the cylinders into water for reconversion into steam as many as 10 to 13 times.

Roller Bearings:—The roller bearings are not dependent on the maintenance of an oil film and have therefore an extremely low starting resistance. In the case of ordinary bearings it is necessary to have an oil film to avoid frictional resistance while starting and until the oilfilm has built up such resistance may go up to 18 lbs. per ton, which under proper Oil Lubricating conditions approximates to a speed of 60-70 miles per hour. In my opinion Railways should resort to the introduction of roller bearings wherever possible.

SCIENTIFIC ADVICE AND CONTROL ON RAILWAYS

By careful study of the various facts connected with the railway industry it becomes evident that the railway needs in the direction of scientific advice and control are practically unlimited. It is hardly realised by non-railwaymen what a diversity of material are used on the railway and to what rigid tests they must comply before they can be accepted for service. The Railways are the largest buyers and users of all industrial products which range from a pin to a boiler. Indian railways for example buy stores worth several crores of rupees as already mentioned.

In the case of metals, we have pig iron of all types, structural steels, alloy steels, ferro-silicon alloys, ferro-manganese alloys, copper, lead, zinc, tin, antimony, aluminium, phosphorus-copper, fusible metals, antifriction metals and hundreds of other alloys. Some of these alloys are forged and rolled whereas others are cast in the Foundry. The heating, forging and casting operations all require very careful scientific supervision and control and any neglect on the part of the operator may lead to very serious consequences due to the defect in the finished product. Since most of the Locomotive parts are subjected to severe working conditions requiring high degree of resistance to wear, heat, fatigue and corrosion, these parts are heat-treated, quenched and tempered under proper scientific direction since even a slight error in metallurgical control would render the metal useless for the job for which it was intended. All these metals before use are subjected to stringent chemical and mechanical tests and their suitability for the particular purpose is fully ascertained.

In the case of failure of metals which occasionally cause derailment or serious accidents, the Railway scientist is expected not only to submit a report about the causes of failure but to suggest ways and means of improving the quality of the metal to avoid further mishaps occurring. The broken tyres, wheels and axles are common occurrences, the causes of which must be diagnosed very carefully. The investigation of Hot Boxes is another very important problem for the Scientist. He must see that proper types of lubricants having high flash-point and correct viscosity are used along with proper types of antifriction metals, which are examined under the microscope before use.

The Railway Scientist has also to see that proper type of refractory materials are purchased on which a sum of over Rs. ten lakhs are spent every year. Physicists are employed to determine the physical properties of fire-bricks such as expansion, contraction, sintering point, and compressive strength at high temperatures under varying loads.

Coal is another important item on the Railways. Every coal supply that is used in a locomotive should be tested in the Laboratory although it is not being done at present and in case of coals having high ash content, their blending with selected grade coal is suggested.

Practically every first class railway in India is equipped with a laboratory where routine testing of materials is carried out. This department deals with the testing of stores and also helps in other ways by giving technical advice and help connected with various problems that arise from day to day.

STATUS OF SCIENTISTS ON INDIAN RAILWAYS

The history of Indian Railways shows that they were not designed on any economic principle, but were started for strategical reasons. The original administration and management of this department was entrusted to high military officials, who were specially brought out from England to run this industry under military discipline, although they had no technical knowledge of railway problems. (This was probably true of most departments of the Government of India of those days; but it was more so in the case of the railways, as their working was then considered to be more or less of a routine nature.)

Not only the locomotives and the rolling stock, but every other item connected with this industry was then purchased from England. Firms of consulting engineers in London were asked for technical advice and help on every engineering matter; and it was not considered necessary to employ any technical or scientific officers on the railways in this country Although great political changes have taken place in our country since then, and many Europeans have been replaced by Indians in some of the important key positions on the Railway, the system of railway working still continues more or less on the same lines, so far as the employment of officers with high scientific and technical qualifications in the Administration is concerned.

It is not generally realised that the standard materials, which used to be supplied by British Firms in the U.K. are no longer readily available there; and, with the departure of some of the experienced technical men, we have been reduced to a somewhat helpless position. The quality of material at present available in our country is much below the standard quality. In a large number of cases, the materials arenot available at all, and substitutes are required to be developed to carry on the work of the

Railway efficiently. All this would require a very serious effort on the part of a large number of trained Indian Scientists, who would have to be employed on the Railways.

As the Hon'ble Mr. Asaf Ali, the then Minister-in-Charge of Transport, stated in one of his speeches—"We can think of no other branch of Science, barring perhaps Astronomy, Biology and Zoology, which does not come into play in relation to the Railway organization at some stage or another."

According to a recent issue of the American Railroads, describing the career of some of the most successful and highly paid men employed thereon, we find that 85% of them held such posts by virtue of their scientific or technical education and experience. Even in the case of the British Railways, the highest administrative posts are held by experienced scientists. In our country, on the other hand, while we hear and read so much about the importance of scientific and technical training for the development of the country, it is both surprising and disheartening to find that no opportunity or scope of any kind is being offered to highly trained and experienced scientific personnel in this key industry of the country. Indian Railways could absorb hundreds of scientists; and I am sure this key industry of ours will derive enormous benefit by their association with the various branches of Railway activity. Unfortunately at present there is no place for a scientist on our railways. I know of no place in this whole industry, where a person with a scientific degree is employed in preference to others. This is a very unfortunate state of affairs and should not be suffered any longer. This is an age of science and competition. As a highly scientific and commercial concern, the Railways cannot afford to neglect the use of science, if they really mean to achieve the maximum success. Moreover, at present our country is facing a period of serious crisis, when all petty and personal considerations must give way and the interests of the country alone should be given the topmost priority

SCIENTIFIC MAN-POWER RESERVE FOR INDIAN RAILWAYS

The work done in the Scientific Laboratories of the Railways is of a highly specialised nature. It requires a comprehensive knowledge of analytical and industrial Chemistry, Fuel Technology and Metallurgy, besides some general engineering experience. The Scientific training given in our schools and colleges is not sufficiently wide or deep, to enable a Science Graduate, however brilliant, to take up the Railway Laboratory work without very extensive post-graduate practical training. We have further no Technological Institutes, where this applied scientific training could be obtained. Therefore, when a new Science Graduate is employed in the Laboratory, a great deal of time and labour of the senior and experienced staff is required to be spent in giving the new recruit the necessary practical training.

The training process generally takes 1 to 2 years. At the end of the period, the majority of these trainees, who could be usefully employed on Railway work, leave the service, as they can get much higher salaries and better prospects in commercial firms, because of the exhaustive and intensive practical training, which they have received in our Railway Laboratories. I know from personal experience that a very large number of our trained Laboratory Scientists have secured very lucrative jobs all over the country; and the training and experience, which they got in the Railway Workshops and Laboratories, has been lost to the Railways. I would, therefore, suggest that the Indian Railways should have a Laboratory

Training Centre, similar to the Training Centre for the Mechanical Apprentices at Jamalpur, where selected batches of Science Graduates could be trained in all branches of testing and scientific control of both ferrous and non-ferrous materials and the other stores purchased by the Railway. A batch of 50 Science Graduates a year would be sufficient to meet the present requirements of Indian Railways. Later on, with the expansion of the existing Laboratories, the number could be increased to meet the growing needs of the Railway Scientific organisation. Ajmer would probably be the most suitable choice for the location of this training centre, as the Locomotive and Carriage & Wagon Workshops there are fairly well equipped for the purpose. The workshops have a Steel manufacturing plant, which can be utilized for the Steel Foundry training. There are also a number of Water Softening Plants close to Ajmer. The existing Railway Scientific Labora tory and Test House could be expanded to cover this scheme.

Following is the general scientific work in which such graduates would be trained in the course of their first year, they could be given specialised training in any one of the following subjects in their second year:—

(1) Cast Iron & Steel Foundaries.
(2) Non-ferrous Foundaries and Fabrication of other Alloys.
(3) Tool Room and Heat Treatment Shop for Metals.
(4) Water Softening.
(5) Manufacture and Utilisation of Paints and Varnishes.
(6) Fuel problems pertaining to Workshops and Locomotives.
(7) Welding, Soldering, Brazing, electroplating and white metalling
(8) Oils, Greases & Lubricants; Soaps and disinfectants, and their application and use.
(9) Chemical and bacteriological examination of waters, and testing of food material.
(10) Control and uses of Refractories, including cement, sands, fire-clays, fire-bricks, silica bricks, etc.

All such trainees should ultimately be absorbed in one of the Railway Departments in which they have specialised, and they should rise to occupy the most responsible positions in due course.

Such trainees should be paid Rs. 100/- P.M. for the two years of the training period. There after, they should be employed on a permanent basis, either in the Scientific Department or in the Railway Workshops, depending upon their progress and suitability for the different lines, in which they have specialised. The trainees should be required to given an undertaking to serve the Railway for atleast five years after completing their training.

NATIONAL FOUNDRY TRAINING CENTRE

The recent establishment of the National Foundry College in England for the purpose of imparting practical training in the melting and casting technique of various metals and alloys has been so widely appreciated that hundreds of applicants from all over the world have been refused admission on account of the limited space available for their training. The Indian

Railways had decided last year to send some of their mechanical engineers to the above College for getting this training. In my opinion money spent for such a training on a mechanical engineer would be completely wasted as the curriculum of this College clearly shows that this training is meant for a qualified metallurgist who should be fully conversant with the Chemistry of Metals and non-metals to get full benefit out of this course. However, I suggest that instead of sending people abroad, a similar foundry training school should be started on Indian Railways for the training of foundry workmen and supervisory staff who are at present quite ignorant about modern methods of production.

At present, most of our senior subordinate staff in the workshops, on whom we depend so much for efficient production, have no technical education of any kind. Most of them have risen to their present position in the vacancies, caused by the departure of European and Muslim employees. It is, therefore, all the more necessary to ensure that we have a number of fully trained technical personnel available with us, to fill up these technical posts in future.

FOREIGN DELEGATIONS

The Government of India have of late been sending a large number of delegations of officers to foreign countries for studying the latest developments pertaining to their respective professions. It is, however, regrettable that so far not a single scientific officer conversant with the scientific problems of the Railways has been included in such delegations for studying up-to-date methods in foreign countries. Even the Technical Mission, which were sent to the U.K., U.S.A. and Australia, did not include any scientist from the Railways. Similarly, the Indian Railway Enquiy Committee, which visited the various Railway Centres in this country with a view to suggest economies, also did not have any Railway Scientist with them, except an officer brought from the U.S.A. for this purpose on a fabulous salary, who could not possibly have the same intimate knowledge of the scientific problems on the railway of this country, as our own Indian Scientists employed on the Railway. It is high time that due recognition were given to local Indian talent on Railways, who should be associated in all development schemes in the country as, besides scientific knowledge and training, they possess considerable practical experience of the various branches of technology as practised in this country.

OPERATIONAL DIFFICULTIES OF INDIAN RAILWAYS

It is not an easy job to run the Railways, as some of our public men are prone to think. The working and maintenance of the Indian Railways is far from simple. The public can hardly realise what a great amount of care the Railway administration takes for their comfort and safety. Every inch of the 35000 odd miles of Railway track is inspected daily. Every nut and bolt used in the Permanent Way is tested before use. All Railway requirements are tested before purchase to most stringent specifications, to avoid any mishaps occurring, due to any defect or the poor quality of the material. Even such items as communication and bunk chains are fully tested to breaking point before permitting their use in service.

At present, the greatest loss to the Railway revenue is caused by the ticketless travellers. During 1946-47, 4½ million travellers were detected travelling without tickets. This means one ticketless passenger for every 235 paying passengers.* The Railways suffer a loss of over Rs. 8 Crores every year on this account. It is, therefore, very necessary for the public to coöperate with the administration to eradicate this evil, which is causing so much financial loss to their national industry.

The Hon'ble Minister of State and the Chief-Commissioner for Railways make very frequent visits to various Railway Centres, in order to establish personal contacts with the public, hear their grievances at first hand and adopt any useful suggestions that the public might make for the advancement of this, our greatest national industry. These are healthy signs; and I am sure the combined efforts made by these chiefs, coupled with the loyal and devoted services of the Railway Personnel-Officers and men—will surely raise the level of efficiency on the Railway to the highest pitch possible.

JAI HIND.

PROCEEDINGS OF THE THIRTY-SEVENTH INDIAN SCIENCE CONGRESS

PART III—ABSTRACTS

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SECTION OF MATHEMATICS

PRESIDENT: PROFESSOR N. M. BASU, D.Sc.

Abstracts

1. Analogues of some $\mu(n)$-Theorems

HANSRAJ GUPTA, Hoshiarpur.

In this paper, the author proves analogues of some theorems involving the Mobius function $\mu(n)$ when it is replaced by Liouville's function $\lambda(n)$. Thus it is shown that

$$g_h(n) = \sum_{d/n} \lambda(d) \log^h d$$

vanishes when the least number m which makes nm a perfect square has at least $(h+1)$ different prime divisors. In particular, $g_0(n)$ is equal to one or zero according as n is or is not a square. Some other striking results are:

$$\sum_{j=1}^{n} [n/j]\, \lambda(j) = [\sqrt{n}];$$

$$\sum_{d_1 d_2 = n} d_1 \lambda(d_1) = \sum_{d^2/n} \phi(n/d^2)$$

where ϕ is Euler's totient function.

2. Properties of a Ramanujan Function

OMAR ALI SIDDIQI, Aligarh.

Consider the Ramanujan Function $\phi(t) = \sum_{n=1}^{\infty} \frac{n^{n-2}}{\underline{n-1}} \cdot t^{n-1} e^{-nt}$ for $t > 1$.

Auluck and Chowla [F. C. Auluck, Proc. Ind. Acad. Sc., 11 (1940), 376-8; S. C. Chowla and F. C. Auluck. Ind. Math. Soc. J. 4(1940), 169-173] proved the conjecture

$(-1)^n \frac{d^n\phi}{dt^n} > 0$ for $n=1, 2, 3$ and also determined the numerical values of $\phi_1(1+0)$, $\phi_2(1+0)$, $\phi_3(1+0)$ {suffixes denoting differentiations}. The transformation $te^{-t} = \omega e^{-\omega}$ where $0 \leqslant \omega \leqslant 1$ and $t \geqslant 1$ was used. Shah (Bombay University Journal, Nov. 1948) and Sharma proved the conjucture for $n=4$ and determined $\phi_4(1+0)$. The author had (Proc. Ind. Sc. Congress, 1949) earlier developed a general method for determining any member of the sequence $\phi_1(1+0)$, $\phi_2(1+0)$, $\phi_3(1+0)$ etc. and proved the conjecture for $t=1+0$. The object of this paper is:—

(1) To establish the lemma

$$\phi_{n+1} = {}^nC_0\phi\omega_{n+1} + {}^nC_1\phi_1\omega_n + {}^nC_2\phi_2\omega_{n-1} + \dots\dots + {}^nC_n\phi_n\omega_1 - \phi_n.$$

(2) To give two different proofs for the conjecture when $t \geqslant n$.

(3) To develop a procedure for discussing the case $t \leqslant n$.

3. A Theorem on Partitions

N. M. BASU, Aligarh.

It is known (G. H. Hardy, *Some famous Problems of the Theory of Numbers and in particular Waring'sProblem,* 1920, p. 10) that the number of partitions of the positive integer n into parts not exceeding 3 is equal to the integer nearest to $(n+3)^2/12$, when the order of the parts is disregarded. It is natural to enquire whether a similar result is true when the order is taken into account.

Let B_n denote the number of partitions of n and $B_n^{(s)}$ denote the number of partitions of n into parts not exceeding S, the order of the parts being taken into account in both the cases. Thus, since

$$4=1+3=3+1=2+2=2+1+1=1+2+1=1+1+2=1+1+1+1$$

we have $B_4=8$, $B_4^{(3)}=7$, $B_4^{(2)}=5$, $B_4^{(1)}=1$. It is known that $B_n=2^{n-1}$, n itself being taken as one of the partitions.

The main result proved in this paper is theTHEOREM : Given the positive integer S, there exists a uniquely determined positive number $\alpha=\alpha(s)$, $\frac{1}{2}<\alpha<1$, such that

$$B_n^{(s)} \sim k/\alpha^{n-1}, \ldots\ldots \tag{A}$$

where $$k = k(\alpha) = (1-\alpha)/\alpha^2 \, [2-(s+1)\alpha^S].$$

It is interesting to observe that $B_n^{(\infty)}=B_n=2^{n-1}$ and $\alpha\rightarrow\frac{1}{2}$, $k\rightarrow1$ when $S\rightarrow\infty$, *i.e.* the righthand side of (A) tends to B_n when $S\rightarrow\infty$.

4. Gibbs Phenomenon for Nörlund Means

B. N. PRASAD *and* J. A. SIDDIQI, Patna.

Let $f(x)$ be function of the class $L(0, 2\pi)$ and let its Fourier Series be

$$\tfrac{1}{2}a_0 + \sum_{n=1}^{\infty} (a_n \cos nx + b_n \sin nx)$$

with the partial sum

$$S_n(x) = \tfrac{1}{2}a_0 + \sum_{\nu=1}^{n} (a_\nu \cos \nu x + b_\nu \sin \nu x).$$

If $N_n^p(x)$ denotes the n-th Nörlund means of the sequence $\{S_n(x)\}$ where

$$N_n^p(x) = \frac{1}{P_n} \sum_{\nu=0}^{n} p_{n-\nu} S_\nu(x),$$

we say that the Nörlund means exhibit the Gibbs Phenomenon at the point $x=x_0$, if

$$\underline{\lim}_{x\rightarrow x_0,\, n\rightarrow\infty} N_n^p(x) < \underline{\lim}_{x\rightarrow x_0} f(x) \leq \overline{\lim}_{x\rightarrow x_0} f(x) < \overline{\lim}_{x\rightarrow x, n\rightarrow\infty} N_n^p(x).$$

If the Phenomenon does not occur, we have

$$\underline{\lim}_{x\rightarrow x_0} f(x) \leq \underline{\lim}_{x\rightarrow x_0, n\rightarrow\infty} N_n^p(x) \leq \overline{\lim}_{x\rightarrow x_0, n\rightarrow\infty} N_n^p(x) \leq \overline{\lim}_{x\rightarrow x_0} f(x).$$

Gibbs Phenomenon has been discussed by a number of previous writers. In this paper we have studied the Phenomenon for the Nörlund means. In particular we, have investigated conditions under which Gibbs Phenomenon would not occur.

5. On the Determination of the Jump of a Function by Nörlund's Means

B. N. PRASAD *and* J. A. SIDDIQI, Patna.

Let $f(x)$ be a function integrable (L) and periodic with period 2π. Let the series conjugate to the Fourier Series corresponding to the function $f(x)$ be

$$\text{(A)} \quad \sum_{n=1}^{\infty} (b_n \cos nx - a_n \sin nx) \equiv \sum_{n=1}^{\infty} C_n(x).$$

If there exists a $D(x)$ such that

$$(1.1) \qquad \psi(t) = f(x+t) - f(x-t) - D(x) = o(1),$$

as $t \to 0$, then $D(x)$ is called the jump of the function $f(x)$ at the point x. Even when (1.1) does not hold, $D(x)$ may satisfy either the relation

$$(1.2) \qquad \psi(t) = \int_0^t |\psi(u)|\,du = o(t)$$

or still more generally the relation

$$(1.3) \qquad \psi_1(t) = \int_0^t \psi(u)\,du = o(t).$$

In each of these latter cases $f(x)$ will be said to have a generalized jump $D(x)$ at the point x.

Employing one or other of the various methods like Cesàro, Riesz, logarithmic, and Abel summabilities and using partial sums of the series (A), the problem of the determination of the jump of a function has been investigated by a number of writers including Fejér, Csillag, Szidon, Lukàcs, Zygmund, Szász, Maruyama, Chow, Minakshisundaram and Misra.

In this paper we obtain several theorems using Nörlund's method of summability. We also investigate the condition under which the generalized jump $D(x)$ defined by (1.3) vanishes. It will be found that many of the previously known results are included in the theorems we have established in this paper.

6. Hypergeometric Summability Involving Infinite Limits

S. K. BASU, Calcutta.

The *hypergeometric summability* of summing a divergent series was introduced by Garabedian and Wall [Trans. American Math. Soc. 1940, 48 (185-207)] as a special type of *Hausdorff summability* [Hausdorff, Math. Zeit., 9(1921), 74-109]. In the present note is considered hypergeometric summability involving infinite limits. Thus if $(H, \alpha, 1, \gamma+1)$ denotes the hypergeometric method of summability and (C, γ) the Cesàro method then it is proved that, for a sequence $\{s_n\}$,

$s_n \to l$ $(H, \alpha, 1, \gamma)$ implies $s_n \to l$ (C, γ) $(-\infty \leqslant l \leqslant \infty)$ $\alpha > 1$, $\gamma > 0$, the case for l finite being already known. Eight other results of this type have also been proved.

7. On Entire Functions of Infinite Order

S. M. SHAH, Aligarh.

Let $f(z)$ be an entire function of infinite order and let $\nu(r)$ denote the rank of the maximum term of $f(z)$ for $|z| = r$. In this paper I have proved the

Theorem: *For every entire function of infinite order*

$$\liminf_{r \to \infty} \frac{\log M(r)}{\nu(r)} = 0 .$$

I have also proved that this is a best possible result

8. Gases with a Pressure-Density Relation: Impossibility of Confocal Distributions

N. L. GHOSH, Calcutta.

The present paper contains a proof of the theorem that a mass of gas in which the pressure depends entirely on the density cannot have a distribution of density in confocal ellipsoids when it rotates steadily about an axis of symmetry. The author in two previous papers has proved the impossibility of density distributions in similar ellipsoids under identical circumstances. The method of proof followed in this paper, as in the case of two earlier ones, is entirely new and the results follow from the inconsistency of such distribution with Poisson's equation together with the equations of motion. Besides, the author does not use the potential function for ellipsoidal stratifications as have been done by all previous workers (Hamy, Veronnet & Dive); as such, the present results hold for any gravitational fields including external fields; moreover as no boundary conditions have been made use of, the impossibility of such stratifications must hold everywhere and consequently the conclusions arrived at in these papers are much more general than those obtained before.

9. Compressible Shear Flow—a Variational Principle

V. R. THIRUVENKATACHAR, Bangalore.

The notion of shear flow, discussed by H. S. Tsien in the case of an incompressible fluid, was extended to compressible fluid flow in a previous paper, where a condition characterising the flow was derived. In this note it is shown that the fundamental equations governing the flow may be derived from a variational principle analogous to the one developed by Lin & Rubinov for steady iso-energetic flows. It is shown further that, with the Kàrmàn-Tsien approximation, the integrand may be transformed into an expression which is identical with the corresponding expression in the iso-energetic case.

10. Some Simple Problems of a Thick Conical Shell

B. SEN, Calcutta.

Stresses in a solid cone due to a force or a couple acting at the vertex were determined by Mitchell (1900) and Ghosh (1936) respectively. In this paper a different but more direct method is employed to find symmetrical stresses in a shell bounded by two co-axial conical surfaces having the same vertex. These stresses are assumed to be caused by either an axial force applied at the common vertex or a couple operating at the same point, the axis of the couple coinciding with that of the shell.

11. An Inversion Formula for the Generalised Laplace Integral

R. S. VARMA.

The object of this paper is to give an inversion formula for the generalised Laplace Integral. This is the sixth formula of the type, three were given by the author a year & half back and two other inversion formulae were given by Mr. K. M. Saxena.

12. Inversion

SAHIB RAM MANDAN.

Certain properties of twelve circles of anti-similitude of four circles two at a time are obtained from some simple properties of a triangle by Inversion. which may be enumerated as below:

(i) Four sets of 6 circles in each set consisting of 3 externals and 3 internals have a common orthogonal circle.

(ii) Four ets of 6 circles in each set consisting of three internals and three externals concur.

(iii) Four sets of 6 circles in each set consisting of all externals or two externals and four internals concur

13. On Summability [R, 1] of a Fourier Series

U. N. Singh, Allahabad.

Let $f(t)$ be a periodic function with period 2π, and of the Lebesgue class L, and let the Fourier series of $f(t)$ be

$$(1) \qquad \tfrac{1}{2} a_0 + \sum_{n=1}^{\infty} (a_n \cos nt + b_n \sin nt) = A_0 + \sum_{n=1}^{\infty} A_n (t).$$

Put $S_n(x) = A_0 + \sum_{\nu=1}^{n} A_\nu (x)$, and $\phi (t) = \frac{1}{2} \{ f(x+t) + f(x-t) - 2S \}$. The following theorem has been proved :—

THEOREM: *If for some x*

$$(2) \qquad \int_0^t | \phi (u) | \, du = 0 \left(t \log \frac{1}{t}\right), \text{ as } t \to 0,$$

and

$$(3) \qquad \int_t^c \frac{\phi^2 (u)}{u^2} \, du = 0 \left\{ \left(\log \frac{1}{t} \right)^2 \right\}, \text{ as } t \to 0,\ 0 < c \leqslant \pi$$

then

$$\sum_{\nu=1}^{n} \frac{|S_\nu(x) - S|}{\nu} = 0 \,(\log n).$$

i.e. the series (1) is summable [R, 1] to S at $t = x$.

14. Differentiation of composite functions

N. Misra, Cuttack.

15. Mixed partial Derivatives of composite Functions

N. Misra, Cuttack.

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SECTION OF STATISTICS

Abstracts

1. Unbiassed Statistics with minimum variance.

A. Bhattacharyya, Calcutta.

Aitken and his school studied the problems of the existence and determination of unbiassed statistics with minimum variance. The author, approaching the problem from another angle, obtained much more general results. In this paper, the author's own results have been further extended.

2. On the construction of Incomplete Probability Integral tables of the classical D^2-statistic.

P. K. Bose, Calcutta.

Author in a paper in Sankhya vol. 8(3) published a set of tables containing the 99%, 95%, 5% and 1% values of L (a transformed variate of D^2) for some specified values of p and Δ^2. It is well known that as p and Δ^2 increase the distribution of classical D^2 statistic tends towards normal. In this paper an attempt has been made to find out for each value of Δ^2 the value of p for which the distribution of D^2 statistic may be taken to be identical with the normal curve for all practical purposes.

3. On the moments of the non-central Chi–square distribution.

M. C. Chakrabarti, Bombay.

Let $x_1, x_2, \ldots, x_n$ be n independent Stochastic variates having normal distributions with means $\mu_1, \mu_2, \ldots, \mu_n$ and a common standard deviation σ. Then the statistic

$\chi'^2 = \sum_{i=1}^{n} x_1/\sigma^2$ is known as non-central chi-square. In the paper (i) the distribution law of χ'^2 has been derived by using the method of characteristic function, (ii) the moments about the origin have been obtained in terms of a finite hypergeometric series and an elegant recursion formula has been obtained which will enable one to calculate from a known moment the higher and lower moments, (iii) a recursion formula has been obtained for moments about the mean. The recursion formulae obtained are believed to be new.

4. A proposed new index of health.

M. W. Chiplonkar, Poona.

At present there does not exist any satisfactory and universal index of health or physical fitness to guide the selection of candidates most suitable for the different civil and military services. The formulae in use are more or less incapable of correctly appraising all the merits and defects which are usually present in a variety of combinations in the examinees. In the present paper a new and sufficiently simple formula has been proposed for the index of physical fitness, J, which not only takes into account all the physical measures of the individual but also the differences of age, sex and race. The formula provides a universal index of physical fitness. It is: $J = L - D/L$, where, L is a function of the various active (or living) elements and D, that of the various inactive (or dead) elements of the individual and are given by the following relations-:—

$$D = a_1 d_1^2 + a_2 d_2^2 + \ldots\ldots\ldots\ldots + a_n d_n^2.$$

$$L = b_1 l_1 + b_2 l_2 + \ldots\ldots\ldots\ldots + b_n l_n.$$

where $d_1, d_2, \ldots d_n$ are the variations of the different physical measures of the individual from the respective class averages, $l_1, l_2, \ldots l_n$ are the variations of the different performances of the individual from their respective class averages, and $a_1, a_2, \ldots a_n$ and $b_1, b_2, \ldots b_n$ are the various corresponding constants representing the relative weights attached to each of the physical measures and performances. It is important to note that besides possessing many other merits the formula clearly differentiates between the active and the inactive elements of an indvidual. The method of using the formula and the choice of the constants involved are described. Typical cases are cited to show its utility.

5. On Systematic Sampling.

A. C. Das, Calcutta.

In one dimensional systematic sampling, defined after Cochran, and taking ν cells from each stratum, even if the strata have got different means but same variance, systematic sampling is more efficient than stratified random sampling if the correlogram be concave upwards.

The best unbiassed linear estimate of $\Sigma l_i \mu_i$ is $\Sigma l_i x_i$ where μ_i is the population mean and x_i the sample mean of the ith stratum, and l_i's are known constants.

Assuming multivariate normal distribution, the maximum likelihood estimate of λ, for $\rho_u = e^{-\lambda u}$, has been found out.

In two dimensional systematic sampling, defined by the author, even if the strata have got different means but same variance, systematic sampling is more efficient than stratified random sampling if the following relations hold good: (*i*) $\delta_1^2 \rho\ (u, v) \geqslant 0$, *ii*) $\delta_2^2 \rho\ (u,v) \geqslant 0$, where δ_1 and δ_2 are usual central difference notations for u and v respectively.

6. Use of Eye Estimates for Crop Forecasts.

D. M. Ganguli, Calcutta.

Crop forecasts prepared on the basis of eye-estimates or guess-estimates have been severely criticised by many. This is probably because in most of the cases these estimates were neither collected through reliable agencies nor were proper precautions taken in their collection for it is a well known fact that the jute mill owners of Calcutta prepare quite reliable estimates of the jute crop on the basis of guesses made by their trained staff.

An experiment was conducted in 1948 in West Bengal to test if guess estimates were of any value in case of Aman paddy. Estimates as compared to the previous years crop were collected from educated cultivators for the purpose. Before they were requested to give their estimates they were asked several other questions regarding the factors that influence the extent of cultivation and the growth of the crop (such as availability of seeds, human labour and bullock labour, weather condition, damage of crops by insects etc.) and were asked to revise their estimates when contradictory statements were given.

On comparison of these guess-estimates with sample survey estimates it was found that the area estimates were quite reliable while the yield estimates were not so.

7. On stratification with Component indices.

A. Ghosh.

Stratification of rural areas with the method of component analysis considering a number of the more important characters have been carried out. It has further been shown that the highest principle component calculated is highly correlated with a comparatively simpler index arrived at from a consideration of the distribution of area owned and area cultivated in that region.

8. Multi-stage Stochastic Models for Natural Fields.

Birendranath Ghosh, Calcutta.

General descriptions of such models have been given earlier (*e.g.*, *Cal. Stat. Assoc. Bull.* 2(5), 22-25; *Science and Culture*, 9, 213-14). Such models can be classfied as a special type of *stochastic processes* on multi-dimensional fields; a $(k+1)$ stage field is supposed to be sub-divided successively in *blocks* of smaller and smaller sizes, the i-th ments, and if the results of the experiments, carried out with the help of such apparatus as are at the command of the scientists at that time, agree with the theoretical results obtained by calculations on the basis of the hypothesis, then the hypothesis is called a 'law'. Thus the laws of applied mathematics, are not really entirely of an objective nature as they depend on so many other factors. Hence they have to change with the progress of science and refinement of the methods of measurement of observed quantities. Sometimes the laws are only slightly modified and sometimes they have to be totally discarded, perhaps to be re-accepted, at least partially, in a new garb. It is therefore not quite correct to think of what is called a law of nature as something like a permanent, ultimate and incontrovertible truth. "In most sciences," says Hermann Hankel[27] "one generation tears down what another has built and what one has established another undoes." Indeed the formulation of new laws are sometimes based on ideas which completely revolutionise the current notions of the physical world. Thus Newton's laws of mechanics and his law of gravitation brought about a revolution in the sense that these gave us probably for the first time an absolute space and an absolute time, independent of each other, and the doctrine of invariability of mass. Another and perhaps even greater revolution was brought about when nearly two centuries after the death of Newton, Einstein propounded his General Theory of Relativity which dashed to the ground all the above three concepts about space, time and matter. On the other hand it is well known how Newton's theory of light as being composed of fast moving particles was discarded in favour of a Wave Theory according to which light consisted merely in the vibrations of an all-pervading medium, the ether, and how again in the recent past the theory of light-quanta all but resuscitated the corpuscular theory from its grave. "The certainties of Science," says Whitehead[28], "are a delusion. They are hedged around with unexplored limitations." The laws of nature have therefore to be constantly sent back to the crucible and recast in the light of new experiences, observations and improved measurements. Thus writes Bertrand Russell[29] about laws of nature: '"The theory of relativity has shown that most of traditional dynamics, which was supposed to contain scientific laws, really consisted of conventions as to measurement, and was strictly analogous to the "great law" that there are always three feet to a yard. In particular, this applies to the conservation of energy. This makes it plausible to suppose, that every apparent law of nature which strikes us as reasonable is not really a law of nature, but a concealed convention, plastered on to nature by our love of what we, in our arrogance, choose to consider rational." A mathematical truth, or what is sometimes called a law of mathematics, stands, however, on a somewhat different footing. . Even so, there are some apparently conflicting views which, it seems to me, arise not so much from the intrinsic nature of the matter but from the angle of vision from which we look at it. Bertrand Russell[30], for instance, holds the view that "Pure Mathematics consists entirely of such asservations as that, if such and such a proposition is true of *anything*, then such and such another proposition is true of that thing. It is essential not to discuss whether the first proposition is really true, and not to mention what the *anything* is of which it is supposed to be true. . . . . Thus mathematics may be defined as the subject in which we never know what we are talking about, nor whether what we are saying is true." Nobody would however deny the intrinsic truth of the Fundamental Theorem of Arithmetic, namely, that every natural number, i.e. a rational positive integer, except 1 is, apart from the order, uniquely representable as a product of the natural primes, or of the statement that $2+2=4$. Such statements are of the nature of absolute and eternal truths about the objects or concepts to which they apply. Pure Mathematics, however, does not consist essentially of absolute or eternal truths in the above sense, for much of the truths of modern mathematics can be styled as such only in a relative sense, although in a somewhat limited sense they may also be described as absolute truths. As a matter of fact in most cases, it is perhaps non-sensical to ask whether a certain mathematical result is either true or false. For instance, it is non-sensical to ask whether the statement $(a+b)^2 = a^2+2ab+b^2$ is true or false unless it is specified what a and b stand for. Mathematicians, however, for a long time believed in the absolute truth of mathematical theorems in the sense of their infallible applicability to human experiences of the physical world although occasionally there have been some sceptics who have questioned such dogmatic beliefs. But this view about the absolute character of mathematical truths was perhaps finally abandoned only after the invention of non-euclidean Geometry by Bolyai and Lobachewsky who showed that there could be consistent geometries other than the Euclidean which might be just as true or as false in their applications, but so far as they were constructions of mathematical systems based on well defined elements and postulates, each was as true as any other; in fact each might be regarded as absolutely true in its own world of ideas. "Modern Mathematics", we may agree with Huxley[31], "is that which knows nothing of observation, nothing of experiment, nothing of induction, nothing of causation," in so far as modern pure mathematics is born of imagination and inspiration of the mind rather than of experiences of nature, although it may be true that the inspiration often comes from such experiences; as for instance, Euclidean Geometry derives its inspiration from spatial experiences. Fired with an inspiration, the pure mathematician weaves his ideas into a pattern utterly regardless of any consideration of application or profit. Whether the pattern woven by him has any counterpart in Nature is a matter of supreme indifference to him. Whether the natural phenomena to which his system is sought to be applied agrees with the pattern evolved by him or not is of no significance since the pattern was created for its own sake and not with the purpose of interpreting any natural phenomenon by a reference to it. Disagreements therefore do not falsify his system in any sense,—the system in its own framework remains eternally true.

Another aspect of mathematical activity consists in its being perhaps the most harmless of human activities. It is not actuated by any ulterior motives, nor contaminated by any earthly desires, for it does not concern the material world at all. As Hardy[32] says: "Both Gauss and lesser mathematicians may be justified in rejoicing that there is at least one science, and that their own, whose very remoteness from ordinary human activities should keep it gentle and clean."

Thus Mathematics being an embodiment of "সত্যম্ শিবম্ সুন্দরম্" the true, the good and the beautiful,—the three principal attributes of Godhood in Hindu Philosophy,—is perhaps the one Science, the disinterested and devoted pursuit of which, more than that of any other, takes man nearer to his Creator.

Now it may very well be asked, if mathematics has really the attributes described above, why is it then that it has so few votaries in this country,—this land with its rich and splendid heritage of spiritualism from time immemorial? My answer is that there are many factors responsible for this, but perhaps the most potent factor is the present general attitude of the people towards the need for the acquisition of mathematical knowledge and its place in a general scheme of education. Most people seem to think that the teaching of higher mathematics is wasteful and that it is enough for all ordinary purposes to learn the elementary rules of Arithmetic. There is accordingly a demand in some quarters for reducing the curriculum in mathematics for the Matriculation Examination to elementary Arithmetic only. Let us therefore consider a little the place and scope of mathematics in the High School curriculum. It seems to me that sufficient serious thought has never been given to this question. Perhaps this may be accounted for by the fact that due to two centuries of slavery and an educational system imposed on us by considerations other than the genuine welfare and progress of the people we were not free either to chalk out our own programme of education or, even if we could do so, to enforce it. Now, however, conditions have changed, our country is free and Free India demands an immediate and searching examination of our educational problems and a re-casting of our educational system in a form that will enable us to occupy an honourable and important place in the comity of nations at the earliest possible date. Our people, unfortunately, are not well informed in educational matters and we must admit, with shame, that we, who belong to the teaching profession, have done next to nothing to see that they are better informed about our subject. We have no organisation like the National Council of Teachers of Mathematics of the United States of America or the Mathematical Association of the United Kingdom, nor any journal of the standard of the Mathematics Teacher or the Mathematical Gazette through which we could come into contact with school teachers and the general public and acquaint them with our aims and ideals. And no plan of reform in any field can be effective unless it has sufficient support of the general public.

Now, what is the real purpose for which mathematics is or should be taught? Is it justifiable to include it as a compulsory subject in the high school curricula for all students when it is well known that a large percentage of the matriculates will never require the use of it in the discharge of their vocations? The following extract[33] from the Report of the National Committee on Mathematical Requirements of the Mathematical Association of America perhaps gives an adequate answer:

> "The primary purposes of the teaching of mathematics should be to develop those powers of understanding and of analyzing relations of quantity and of space which are necessary to an insight into and control over our environment and to an appreciation of the progress of civilisation in its various aspects, and to develop those habits of thought and of action which will make these powers effective in the life of the individual."

There is of course also what may be called a secondary purpose, though not applicable to all, namely that of equipping the students for training in the technical sciences which is so necessary for the material welfare of humanity at large and also, in a somewhat narrower sense, for the management of statecraft and defence of the nation. But it is essentially for the primary purposes mentioned above that mathematics of a fairly high standard has an important and almost mandatory place in any scheme of general education in every progressive country of the world. Unfortunately this has not been properly understood or appreciated by the educated public in this country who still think of Mathematics as a computer's art and do not realise that[34], "Mathematics is no more the art of reckoning and computation than architecture is the art of making bricks or hewing wood, no more than painting is the art of mixing colours on a palette, no more than the science of geology is the art of breaking rocks, or the science of anatomy the art of butchering." This aspect of the aim of teaching mathematics will perhaps not be properly recognised by any but a very limited circle of our people until school Mathematics is sufficiently reformed and the curriculum and standard of teaching are made of a slightly more advanced character in order to provide some inkling of the vital role which mathematics plays in modern life and the profound influence it has brought to bear on all departments of thought. "In the Secondary Schools," says H.G. Wells[35], "Mathematics should be a part of general culture and not contributory to technical training of any kind. . . . . Mathematics is a quite indispensable factor of general education in so far as the latter shows its traces in the comprehension of the development of civilisation and the ability to participate in the further tasks of civilisation." It is therefore necessary to reform school education suitably so as to introduce the notion of functionality even at the school stage for, as Klein said, "the world is being functionally minded" and without a notion of functionality it is not possible for anyone to understand modern civilisation and its trends. It will be pointed out, I know, that the curriculum of school mathematics is heavy enough and nothing more can be added to it. But that is exactly my point,—it is loaded with a good deal of rubbish which can be safely scrapped. This should be done and a reformed and revitalized curriculum should be framed as early as possible. The movement for reforms in the curricula and methods of teaching of mathematics first started in Germany more than a century ago in 1816, when the programme known as the Prussian Lehrplan was formulated. What wonder then that Germany became the home of mathematical learning and the Germans more scientifically advanced than all other nations? This Lehrplan however did not prove quite satisfactory and had to be modified from time to time. The reform movement continued and in 1873, when the country had begun to settle down after the Great War of 1871, the Prussian Minister of Education summoned a conference to discuss the question of mathematicl education in all its bearings. At about this time the movement spread into France and early in the twentieth century it spread to other European countries and America as well. I need not go into the detailed history of the progress of this movement but it is worthwhile to mention that as a result of the discussions held at the Fourth International Congress of Mathematicians at Rome in 1908, a committee known as the "Internationale Mathematische Unterrichts Kommission" (International Commission on the Teaching of Mathematics) was set up with Felix Klein as its Chairman, for the purpose of studying and comparing the tendencies in the teaching of mathematics in various countries and submitting a report to the next meeting of the Congress. A National Committee on Mathematical Requirements was set up in America and their report entitled "The Reorganisation of Mathematics in Secondary Schools" published in 1923 'is generally recognised as a landmark in the history of American mathematical education.' Most nations have had their own national committees and have profited by the study of the reforms proposed and carried out in other countries. In India alone the century-old out-worn programme with hardly any reform is still being followed. Any attempt at reform made by professional mathematicians here and there have been, as I know from personal experience, stubbornly opposed by our educational senators most of whom have no idea of what mathematics is. The following criticism of the guardians of American secondary education made by Dr.

Jesse Newlon at the 1932 Conference on Secondary Education seems to me to be very well applicable to conditions in India even in 1950:

> The American secondary school is a stronghold of conservation where the curriculum is hopelessly traditional and not vitally connected with the needs of youth. The inertia of the secondary school is tremendous. Its teachers and administrators, with few exceptions, are but stereotypes of an outworn concept of education. Every attempt to effect fundamental changes have been stubbornly resisted by a majority of its personnel.

This state of affairs is principally due to the fact that even the educated section of the public, not to speak of the general public, hardly realise that "every major concern among the intellectual concerns of man is", as Professor Keyser[36] puts it, , "a concern of mathematics" and that tne study of some advanced mathematics is important not simply because of its utilitarian value in the narrow sense as a master tool for sicentific inventions, but chiefly because in our modern civilisation it has to be regarded as one of the Humanities, the study of which is indispensable for a rational life ; for it inculcates the habit of correct thinking and "correct thinking, based on true premises secures the mastery of the world"[37]. The world we live in is not static. Change is the great Master that inexorably and pitilessly rules us all and we should not forget that "mathematics consists mainly in the study of functions and the study of functions is the study of the ways in which changes in one or more things produce changes in others"[38].

If all that has been said above be granted, then it is incumbent upon us to formulate a plan of teaching mathematics which will be interesting enough to attract even students of average ability. The present position in schools is however such that the very name of mathematics is a bugbear to even some of the best intellects who shrink from it with a sense of horror and disgust and keep away from it as soon as they have passed the school stage when it is no more a compulsory subject of college studies. Now what should we do to remedy this state of affairs ? I shall mention only some of the things which I think should be done without any delay..

First, a reform of the school curriculum is absolutely necessary. All non-essentials,—and there are quite a lot of them,—should be ruthlessly weeded out and such new matters should be included as would give the young learners a glimpse of the true and beautiful in mathematics and awaken in them a curiosity to learn more of the subject and to dive deep into its pools of everlasting joy and pleasure.

Secondly, the method of teaching mathematics should be revised so as to introduce the aspect of rigour, even at the school stage, wherever possible. I know there are many who will object to the introduction of rigour at this stage but let us see what some great savants have to say about it. Pringsheim[39] says, "I have come to the conclusion that the exertion, without which a knowledge of mathematics cannot be acquired, is not materially increased by logical rigour in the method of instruction". According to D'Alembert[40] "the only way in which to treat the elements of an exact and rigorous science is to apply to them all the rigour and exactness possible. And Hilbert[41], one of the greatest mathematicians of the recent past, declares : "It is an error to believe that rigour in proof is an enemy of simplicity. On the contrary we find it confirmed by numerous examples that the rigorous method is at the same time the simpler and the more easily comprehended". The baneful effect of neglecting rigour where it can be easily applied can hardly be over-emphasised. Loose thinking in the initial stages engenders a habit of mind from which it is difficult to extricate oneself at a later stage when rigorous thinking is indispensable. To quote Whitehead[42]: "When the initial statements are vague and slipshod, at every subsequent stage of thought, common sense has to step in to limit applications and to explain meanings. Now in creative thought common sense is a bad master. It can only act by suppressing originality."

Thirdly, teachers of mathematics should be selected with the utmost care. It should be borne in mind that no teacher can be really effective as a teacher if the range of his knowledge extends only as far as or just beyond the course he has to teach. Not infrequently it happens that a university or college student has to unlearn certain things which he has previously 'learnt' and it is always more difficult to unlearn than to learn. It is not enough that a teacher has been trained in the *methods* of teaching at a teachers' training college which is usually regarded as a sufficient guarantee of his teaching ability . It is good to know the method but what does it avail if he has not acquired mastery over the content? And it is impossible for any one to acquire such mastery unless his knowledge extends well beyond the subject matter of his teaching.

Fourthly, text books, before they are placed in the hands of young learners, should be critically examined as to the statements and proofs given therein even if they are judged to be suitable otherwise. Sometimes for want of a really good text -book it may be necessary to prescribe a badly written book but in all such cases it should be possible for the teacher to point out the defects and to supplement the book by his own teaching.

In what I have stated above I have only tried to emphasise the need for reform and not to give any but a very rough outline of the lines along which reform should be carried out. I have only tried to show that while other nations were awakened by pressing needs long ago, we have all this time been deep in slumber. They have forged ahead and we are lagging miles behind. It is therefore high time that we also exert ourselves in effecting much needed reforms and try to set our house in order. But no effort in this direction can be fruitful unless it is made in an organised manner and is backed by public opinion. It is perhaps pertinent to ask what our national governments, central and provincial, have done in this matter. Perhaps it will be said that the Central Government has not been unmindful of its responsibility and had recently appointed a strong Universities Commission, the report of which has been submitted though not yet published.* While heartily appreciating the laudable desire of the Government for necessary reforms in University education, may I suggest without any disrespect to Government that a Commission of the type appointed by Government can only make recommendations,—perhaps very wise recommendations,—regarding the organisation of education, but they can hardly make any recommendations regarding curricula in general. It seems to me therefore that the report of the Commission will contain hardly anything helpful for the solution of the problems I have been discussing. I suggest that a special committee be set up without delay, with appropriate sub-committees, to go into the question of mathematical studies in our schools, colleges and universities, in view of the fundamental role which mathematics plays in human affairs generally and the sciences in particular. The scientific age is far too advanced to brook any delay in this matter and the sooner it is realised, the better for the country and the nation.

So far I have referred to only one of the factors responsible for the present unsatisfactory state of progress of Mathematics in this country, namely, the lamentable ignorance of the general public about the place of mathematics in modern education and the consequent neglect of school mathematics. Ther are however various other factors also contributing to this state of affairs. One of these is the fact that the main object for which a university career is sought by the youth in this country, as perhaps elsewhere also, is that of qualifying themselves for fairly lucrative jobs which would enable them to lead a more or less comfortable life. Our best brains are therefore, unfortuntely for our country, attracted to those subjects, which are likely to bring good dividends to the largest number, and mathematics is not one of these dividend-earning subjects. Another reason can perhaps be found in the nature of the question papers in mathematics set for the various competitive examinations conducted by our public service commissions which many of our gifted young men make up their minds to take, even from the beginining of their university career. So far as I know the questions in mathematics usually asked at most of these examinations demand a very highly developed skill in manipulation and the ability to solve most complex and complicated problems like those asked in the old Cambridge Tripos Examinations. It is difficult to understand the object of such a test in mathematics for the recruitment of administrative officers. One should have thought that mainly such questions would be asked as are likely to bring out the real mental faculties of the candidates,—their power of comprehension, logical thinking and lucid exposition,—rather than the ability to solve antiquated problems which is hardly of value in any walk of life. Since mathematics is not a compulsory subject, the candidate who has to offer mathematics as one of the subjects of examination is severely handicapped in comparison with one who can avoid it. This therefore acts as a strong deterrent on even those young men who have a natural inclination for mathematics and diverts them to other courses of study after they pass the school stage to the great detriment of the progress of mathematics in our country. Lastly it seems to me mathematical studies have not so far received sufficient encouragement from Government. Our national Government has planned eleven national laboratories and technological institutions but one sadly misses in the list an Institute for Mathematical Research. Why is this omission ? Perhaps because mathematics is considered a comparatively unimportant subject whose progress can wait and perhaps it is thought that researches in pure mathematics are little useful as most of them are mere speculations in thought and unrelated to the physical world. Said Voltaire[43] : "In Geometry, as in most sciences, it is very rare that an isolated proposition is of immediate utility. But the theories most powerful in practice are formed of propositions which curiosity alone brought to light and which long remained useless without its being able to divine in what way they should one day cease to be so. In this sense it may be said, that in real science, no theory, no research, is in effect useless." Lessons of history are easily forgotten and it may therefore be worthwhile to remind our countrymen that the study of Conic Sections, originated by Plato, continued to be pursued enthusiastically century after century without any apparent purpose, save perhaps for the enjoyment of the intellectual pleasure that could be derived from a contemplation of those beautiful curves and their remarkable properties. But nearly eighteen centuries afterwards, the genius of Newton was able to produce the fruit of those studies,—perhaps the most wonderful fruit of pure mathematical studies,- in the shape of his famous law of gravitiation the light of which all of a sudden illumined the universe and held out the most efficient instrument for the unravelling of its mysteries. Abstruse mathematical researches should not therefore be neglected or disdained simply because they have no application at the moment. History has shown that there is hardly any branch of abstruse mathematics which has not sooner or later found applications in unexpected and unsuspected manners. The establishment of an Institute of Mathematical Research with necessary equipments and staff can there fore be more than amply justified as a sound investment, and surely our national Government would be well advised to take early steps in the matter.

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* The report was published when this address was in the press.

I have talked long enough without however being able to touch more than a fringe of the problems that face us. I have said practically nothing about higher mathematical studies and research although I wish I had sufficient time at my disposal to be able to do so. My remarks have been mainly directed to the need for placing mathematical education in the secondary schools on a sound basis, for unless we are able to secure a strong foundation and to create a proper attitude towards mathematics, it is idle to expect any improvement in the standard of higher mathematical studies and research ; and Free India must, with steadfast zeal and unswerving determination, encourage and promote such research if she is not to slide back into slavery once again. I must, however, now bring this talk to a close and I think I can do it no better than by quoting the following passage[44] which sets forth in beautiful language an appreciation of the nature of mathematics and which I am sure will strike a concordant note in every mathematician's heart :

> Coterminous with space and coeval with time is the Kingdom of Mathematics; within this range her dominion is supreme; otherwise than according to her order nothing can exist; in contradiction to her laws nothing takes place. On her mysterious scroll is to be found written for those who can read it that which has been, that which is, and that which is to come. Everything material which is the subject of knowledge has number, order, or position; and these are her first outlines for a sketch of the Universe. If our feeble hands cannot follow out the details, still her part has been drawn with an unerring pen, and her work cannot be gainsaid. So wide is the range of mathematical sciences, so indefinitely may it extend beyond our actual powers of manipulation that at some mements we are inclined to fall down with even more than reverence before her majestic presence. But so strictly limited are her promises and powers, about so much that we might wish to know does she offer no information whatever, that at other moments we are fain to call her results but a vain thing, and to reject them as a stone where we had asked for bread. If one aspect of the subject encourages our hopes, so does the other tend to chasten our desires, and he is perhaps the wisest, and in the long run the happiest, among his fellows, who has learned not only this science, but also the larger lesson which it directly teaches, namely, to temper our aspirations to that which is possible, to moderate our desires to that which is attainable, to restrict our hopes to that of which accomplishment, if not immediately practicable, is at least distinctly within the range of conception.

REFERENCES

1. Bacon, Francis. *Advancement of Learning*, Bk. 2.
2. Sylvester, J. J. *Collected Mathematical Papers*, Vol. 3, p. 424.
3. Russell, Bertrand. *Principles of Mathematics*, p. 1.
4. Howison, G. H. *The Departments of Mathematics and their Mutual Relations. Journal of Speculative Philosophy*, Vol. 5.
5. Klein, Felix. *Anwendung der Differential-und Integralrechnung auf Geometrie*, (1902). p. 26
6. Pringsheim, Alfred. *Jahresberichte der Deutschen Mathematikar Vereinigung* (1904), p. 357.
7. McCormack, T. J. *On the Nature of Scientific Law and Scientific Explanation*, Monist, Vol. 10, p. 555.
8. *Leibnizens Mathematische Schriften*, Book V, p. 307
9. Bernoulli, J. *Opera*, Tome II, pp. 241, 255 and Tome III, p. 174

$$\frac{P}{P_0} = \left(\frac{S}{S_0}\right)^{\delta}$$

$\delta \neq c_p/c_v$)

homologous radial motion of a star is possible when:

$$\delta = \frac{4}{3}$$

and the law of opacity and subatomic energy generation are of the form:

$$K \infty \left(\frac{S}{T^3}\right)^{\alpha} T^{-\frac{5}{2}}$$

$$\varepsilon = \left(\frac{S}{T^3}\right)^{b} T^{\frac{5}{2}}$$

5. The theory of meson and its interaction with Nuclear Particles.

R. C. MAJUMDAR, Delhi.

The fundamental equations of meson field were originally obtained by Yukawa and Proca as a generalisation of the electromagnetic field equations and its interaction with nuclear particles was introduced with the help of the 4-vector potential of the field. The spin of the meson was expressed as a polarisation of the wave function, such that, for a meson of spin unity there are three independent states of polarisation for a given momentum, two of them being transverse and the other one longitudinal. In this wave formulation we are to perform the calculations separately for the longitudinally and transversely polarised mesons and then finally sum or average over various polarisations. As obvious, therefore, the calculations become extremely lengthy and laborious. Now since the mesons which are observed in cosmic rays are mostly charged Kemmer considered it desirable to build up a particle theory of mesons as a generalisation of Dirac's theory of electrons. In this particle formulation although the interaction of the mesons with electromagnetic field present no difficulty the calculation of their interaction with the nuclear particles, however, is not at all straightforward. In the present paper the interaction of the meson with the nuclear particles has been investigated with the help of a column vector matrix Γ first introduced by Harish-Chandra which allows the calculation to be carried out in an elegant and straightforward way. The scattering of various types of mesons by the neclear particles and the interaction between the nuclear particles themselves have been completey worked out and the results are discussed with reference to the observational data on cosmic rays.

2. SPECTROSCOPY

6. Structure of 3rd band of Iron and Magnetic and non-magnetic Iron compounds and alloys, by Soft X-ray Spectroscopy.

K. DAS GUPTA, Calcutta.

The structure of 3d band of Iron in the region of 17.5 A.U. corresponding to the transition of $M_{IV, V}$ electrons to the vacant $L_{II, III}$ level have been investigated by a bent mica crystal grating in Siegbahn spectrograph. $L_{\alpha_{1,2}}$ is due to the transition $M_{IV, V} \rightarrow L_{III}$ and $L\beta_1$ due to $M_{IV} - L_{II}$. $L_{\alpha_{1,2}}$ bands have been taken for pure iron, *$Fe_2 0_3$, (Fes)*, $Fe_3 0_4$, (Fes), Fe-Si (14%Si), *Fe-Si* (55%Si), Fe-Si (4%Si, Stalloy), Fe-Al 21%Al), *Fe-Cu*(85% *Cu*). The under lined samples being non-magnetic and the rest Ferro-magnetic. In each of the samples a broad band has been obtained, the wave-length of the peak of the band being 17, 17,565X.U. Only the band for pure iron is shifted and the wavelength of the peak is 17,572 X.U.

The most interesting observation in this investigation is the appearance of an extra band on the short wavelength side of the main 3d band in the case of samples in which ferro-magnetism has been quenched by the formation of alloys or compounds.

This extra band which is so prominent in the case of non-magnetic Ferrous alloys and compounds appears very faintly in the case of ferro-magnetic samples like pure iron, magnetite $(Fe_3 O_4)$, Stalloy, (FeS).

Data so far collected point qualitatively to the fact that the intensity of the extra band detected is to be correlated with magnetic Susceptibility. The experimental results obtained have thrown much light on the present idea of 3d band structure of Ferromagnetic materials.

7. Soft X-ray Absorption and Emission Spectra of Alkali-halides.

K. DAS GUPTA, Calcutta.

K valence band emission spectra corresponding to the transiton of valence electrons into inner vacant K level have been taken in the case of metal ion in NaF, NaCl, NaBr, NaI with a concave Gypsum crystal grating spectrograph designed by Prof. Siegbahn. Chlorine K valence band spectra in the second order have been taken for alkali-chlorides, alkaline-earth chlorides. K absorption spectra of Na in NaF and NaCl have also been taken. Considering K absorption data of Chlorine in various chlorides of Stelling and of Na in Sodium-halides by K. C. Rule of Upsala it has been possible to draw electronic level structures of the valence electrons in such solids.

The energy diagram of valence electrons thus drawn from the absorption and emission data explains in a straightforward way the origin of the fundamental ultra-violet absorption bands of alkali-halides. A good agreement between the values of ultraviolet absorption bands as directly obtained by Hilsch and Pohl and as obtained from soft X-ray emission and absorption data of Halogen ion, as well as, of alkali ion for various halides supports the new explanation as to the origin of these ultra-violet absorption bands in alkali-halides.

8. Fluctuation of intensity in the D. C. Mercury arc.

C. K. SUNDARACHAR, Tumkur.

An experimental study of the luminosity in the region close to the cathode of a low pressure mercury arc fed from a D.C. supply, using a vibrograph camera arrangement, reveals a variation of intensity of a period of about 0.002 seconds. The origin of this phenomenon is discussed with reference to some of the well-established characteristics in respect of the arc discharge. The view is put forward that the random motion of the cathode spot and the high velocity vapour stream from the cathode bring about the fluctuation in intensity.

9. Excitation of Nitrogen band in the sodium arc.

C. SRINIVASAN *and* C. K. SUNDARACHAR, Tumkur.

It is found that the first negative bands of Nitrogen are brought out with great intensity in spectrogram of the radiation from a high current low pressure sodium arc, containing an admixture of nitrogen. The possible mechanism of the excitation of these bands in the sodium arc is discussed, on the basis of theories of the origin of nitrogen bands in the afterglow of active nitrogen and the aurora.

The view is put forward that the nitrogen bands observed in the sodium arc discharge arise from collisions of the first kind betw een ground-state $(x^1) \Sigma N_2$ molecules and fast electrons.

10. A Note on the Estimate of the Dissociation Energy of C_2 (Swan):

N. R. TAWDE *and* M. G. K. MENON, Bombay.

Recently Tawde and Menon have reported some parallelism between h.p. and Swan bands of Carbon. These results, in general, go to support the hypothesis of Herzberg regarding $D(C_2)$ which he estimates as 3.6. v. According to Gaydon it is expected to, be not less than 4 e.v. Tawde from intensity observations arrives at a value 4.2 ± 0.1 e.v. Johnson and Asundi's evidence is in favour of value higher than 3.6 e.v. of Herzberg, and this receives support from Singh. The very recent computation of Phillips giving 5.3 e.v. is considered to be high estimate. All the spectroscopic derivations take along with the estimate $D(C_2)$ 4.7 e.v. from vapour pressure and sublimation data bring the subject to an interesting stage. The note gives a critical discussion of the whole aspect.

11. Excitation of Carbon bands in Neon.

N. R. Tawde *and* (Miss)V. Rajeswari, Bombay.

Systematic study of the excitation of the spectra associated with carbon as an auxiliary to the spectroscopic study of combustion in flames has been undertaken. The results with argon have already been reported. This investigation relates to neon gas excitation. The spectrum reveals considerable presence of atomic lines of neon (unlike argon), the C_2 (Swan), the CH (4300) and probably the triplet bands. It is thought from the behaviour of the results that the energy transfer phenomenon is of resonant type as in argon, but less efficient.

12. A Case of Quantum Mechanical Resonance in Energy Transfei Phenomenon—CO Discharge.

N. R. Tawde *and* M. G. K. Menon, Bombay.

It was shown in an earlier note that the selective enhancement of Swan bands in argon at a pressure of 15 mm. of Hg. was a consequence of resonance effect in energy transfer by inelastic collisions. It has been further noticed in recent investigations on CO discharge that Swan bands are brought about in it at a pressure of about 15 mm. and again in the neighbourhood of about 30 mm. with selective behaviour. The selective effects in argon as well as in CO might be interpreted in terms of migration of energy between excited and unexcited entities, so as to connect the time between two collisions with the mean radiative life-time by a quantum relation.

13. Theoretical Transition Probabilities in C_2 (Swan) Bands.

N. R. Tawde, Bombay.

Recently King (Astrophys. J. *108*, 429, 1948) has measured the intensities of Swan bands excited in electric furnace. The results have been compared with the theoretical and experimental work of other investigators, viz. Mckeller and Buscombe and Johnson and Tawde, resp. Patel (Ph.D. thesis, Bombay, 1947) in this laboratory some years ago, has carried out the calculations of transition probabilities from Hutchisson's intensity integral. The values of some of these appear to be at considerable variance with those of Mckeller and Buscombe. Attempt is made to trace the causes of disparity and to examine the theoretical transition probabilities in terms of several experimental results.

14. Relative Resonance Distributions in D_1 D_2 Lines of Sodium.

N. R. Tawde *and* G. K. Mehta, Bombay.

The measure of self-reversal of the two components of sodium doublet has been obtained by resolving the lines. Each of the line shapes shows a similar resonance distribution but the absorption parameter p in the case of high frequency component of the doublet has been found to be different from that of low frequency one, indicating the ratio of the concentrations of emitting and absorbing atoms n_e/n_a to be smaller for 5890 line and thus a higher resonant effect in that wave-length.

15. Multiplet Separations in the Complex Spectra of Diatomic Molucules.

V. Ramakrishna Rao, Waltair.

In the analysis of the complex spectra of diatomic molecules like the Hydrides and Halides of Manganese, Chromium and Titanium etc., it is observed that an idea of the order of Multiplet separations is more important than that of the vibrational intervals. Attempts are made to arrive at the probable order of magnitude of the Multiplet separations by comparing the A factor in the molecule MX with the A factor for:

1. the corresponding atomic terms in the element M,
2. the corresponding atomic terms in the singly ionised element M^+,
3. the corresponding atomic terms in the neutral element isoelectronic with M^+.

A comparative study showed that the data from methods 1 and 2 are more reliable and may be taken recourse to in arriving at the probable order of multiplet separations.

16. Intensity of Fluorescence in relation to Polarisation and Lifetime.

N. R. TAWDE *and* N. RAMANATHAN, Bombay.

The intensity, polarisation and lifetime of excited states of molecules are closely related. On considerations of the probabilities of deactivation of excited molecules by emission of light or by other modes, it is concluded from observations on dyestuff solutions that while viscosity and temperature do nota ffect the intensity of the fluorescent light at the ranges employed in the investigation, concentration of the dyestuff influences the intensity to a great extent. A critical concentration of the fluorescent substance exists in the case of every fluorescent solution, above which all the three factors of intensity, polarisation and lifetime decrease with concentration and below which the latter two remain constant while the intensity decrease in concentration. That all the three tend to zero value is shown by the fact that dyestuffs do not fluoresce when they are not in solution.

3. Meteorology Geophysice, Oceanography.

17. The Diurnal and seasonal Variations of the 'Surface' Wind at Vizagapatam.

K. S. AGARWALA, New Delhi.

In continuation of the author's previous work (Proc. 36th Indian Sci. Cong. Allahabad, 1949, Part III, Phys. Sec.) the present paper discusses the diurnal and seasonal variations of the wind at Vizagapatam at a height of 56½ feet above ground. Curves showing the mean diurnal variation of the wind speed for the twelve months of the year are given and discussed: these curves generally show two maxima—a strong one in the early afternoon and a feeble one at night or in the early morning hours. A rough estimate of the value of the coefficient of eddy diffusion works out to be 137 in C.G.S. units. Tables of frequencies of prevailing wind direction at 3-hourly intervals for each month of the year are given and their interesting features are described; a table showing the diurnal variation of 'calms' is also included. The general characteristics of land and sea breezes occurring at the station are briefly mentioned. The annual variation of the velocity and direction of wind as well as its steadiness is also briefly discussed. The mean monthly steadiness is found to vary from 60% to 92%.

18. Fluctuations of Annual Rainfall in Central India, 1872-1947.

K. S. AGARWALA, New Delhi.

In a paper (India Met. Dept. Memoirs Vol. XXI, Part I) on the meteorological evidence for supposed changes of climate in India, published in 1910, Sir Gilbert Walker had come to the conclusion that although there was no proof of any permanent climatic change, there had been a tendency over Northwest and Central India for the rainfall to fluctuate considerably. The present paper examines the question further for Central India and presents the results of study of the annual rainfall data for Central India for the seventysix years 1872-1947. Tables and graphs showing the year to year variations, 10—year means and means for longer periods are given to indicate the general trend of the fluctuations in the annual rainfall and their chief features are discussed. The two driest years were 1899 and 1918 with annual rainfall 23".45 and 23".08 respectively and the wettest year was 1934 with annual rainfall of 58".74 while the average for the period 1872-1947 is 40".92. The data do not suggest any permanent climatic change in Central India. There are, however, indications of a wet period alternating with a dry one. The rainfall deficiencies from 1895 to 1921 point to a dry period. A wet period set in from 1922 and there has been a tendency for an increase in the annual rainfall since then. If the indication of alternative wet and dry periods remains significant, it is possible that a downward trend may begin in the years ahead.

19. The Lunar Atmospheric Tide at Trivandrum and Augustia.

S. K. Pramanik, Poona.

Chapman and co-workers have given determinations of the atmospheric lunar tide at a large number of stations and the author and co-workers for 3 stations in India. The present paper gives the lunar atmospheric tide at Trivandrum and Augustia.

The data of Trivandrum consisted of hourly eye observations of barometer except on Sundays for the periods 1853-55 and 1856-64, and for Augustia consisted of similar observations for the periods January 1856 to September 1858 and June to December 1864. The data were analysed by the Chapman-Miller method.

The mean annual tide only was determined for Augustia and for Trivandrum for the years 1853-56 as the periods were short, but for Trivandrum for the years 1856-1864 the seasonal values of the tide were also determined.

The values of the semidiurnal component (C_2) and the phase (θ_2) of the lunar tide with the probable error (P.E.) and the number of days (N) are given below.

Station	N	C_2	θ_2	P.E.
Trivandrum (1853-55)	938	40.0	70.2°	±6.5
Trivandrum (1856-64)	2815	54.2	74.1°	±6.1
Trivandrum (1953-55 & (1856-64)	3753	50.7	73.1°	±6.2
Augustia	914	49.3	75.2°	±7.2

As found previously of two places close by at considerably different hights the amplitude at the higher place Augustia is also less and the phase greater than at Trivandrum.

The seasonal values of the second component of the lunar tide at Trivandrum are given below.

Season	N	C_2	θ_2	P.E.
J	947	61.0	104.5°	± 9.6
E	943	53.4	71.7°	±10.5
D	925	63.8	47.2°	±11.9

20. Performance Characteristics of the Fan-type Radiosonde.

V. Kalyanasundaram, New Delhi.

The paper presents the results of a number of soundings made at Poona with two F-type radiosondes attached to the same baloon. The differences between the dry bulb and wet bulb temperatures recorded by the two instruments at the standard pressure levels have been worked out. The performance of the aneroid and the dry and wet bimetals of the two instruments has been independently studed and from more than a hundred "comparative ascents" it has been found that any two aneroids generally record a difference of 3 to 6 millibars and any two bimetals record a difference less than 1°C. The agreement between the pressure and temperature measurements of the two instruments without and after applying the zero shift correction is also examined. The paper also presents the results of a few experiments made in the laboratory on the temperature effect and the hysteresis lag on the radiosonde aneroids.

21. A Study of the Speed Rotation of the Fan of the F-type Radio-meteorograph during Ascent.

A. P. Jayarajan

The variation of the rate of rotation of the fan operating the F-type radio-meteorograph over Poona with height was analysed. From the preliminary examination made, it appears to decrease with height up to the 600 mb. level above which it remains almost steady up to about the 400 mb. level above which, the rate increases during winter and decreases during the monsoon. An examination of the rate of rotation of the fan and the wind speed at various levels showed that generally there was increase in speed of rotation when the wind speed increased. Whether the increase in the rate of rotation is associated with regions of increased rate of ascent of the balloon in these regions is under examination.

22. Response characteristics of Electromagnetic seismographs to an impressed Impulse and their dependence on the Instrumental Constants.

S. K. CHAKRABARTY, Calcutta.

The works of Jeffreys and others have shown that the nature of disturbances produduced by the arrival of P and S waves associated with an earthquake is more to an impulsive motion than to a simple harmonic motion. The response of an electromagnetic seismograph of the most general type, when the seismometer frame is subjected to an impulsive force has been worked out theoretically and the variation of the response with the change of the instrumental constants have been analysed. The results thus obtained have been discussed in relation to the interpretation of the data pertaining to the seismological methods of prospecting for oils and minerals and those relating to earthquake seismology which are used for the geological study of the internal constitution of the earth.

23. On Blackett's Fundamental Theory of Magnetism by Rotation.

K. S. RAJA RAO.

Blackett's formula $P = \frac{G^{\frac{1}{2}}}{c} U$ is examined vectorially and found to be unbalanced.

It is found that on account of the obliquity of the axes of magnetisation and of rotation, the law is unable to explain the asymmetry of the earth's magnetic field. The phenomenon of secular variation cannot be explained by the fundamental theory of magnetism by rotation. In the case of the sun, the series of experiments show that the general megnetic field is not constant, but varying and hence the fundamental law cannot be applied. Chapman has shown that the large magnetic fields of the sunspots also cannot be explained, according to Blackett's theory. Hence the law cannot be claimed as a general law of nature.

24. The Geomagnetic Equator.

K. S. RAJA RAO.

The essential distinction between magnetic and geomagnetic latitudes is brought out. The polarisation of radio waves at Huancayo show that the geomagnetic latitudes are controlled by the ionosphere. Appleton's plot of F2 critical frequencies against geomagnetic latitudes shows that the latter have to be used for ionospheric work. The apparent divergence between the magnetic and geomagnetic latitudes is explained. The idea of eccentric dipole, as opposed to centric dipole, is brought out. The assymmetry in the earth's field is able to explain the cosmic ray observation of clay and others. A map of Southern India showing magnetic and geomagnetic latitudes has been drawn. It is suggested that for all physical problems connected with cosmic rays and ionosphere, the geomagnetic latitudes have to be used.

4. Light

25. Polarisation of Light Scattered by liquid Droplets.

M. M. PARANJPE *and* M. V. SHINGRE, Bombay.

The polarisation of light scatterd by liquid droplets was computed on Mie's electromagnetic theory of scattered light. An experimental verification of the computed results was also carried out for certain values of scattering angles. It is found that the polarisation obtained experimentally agrees with the theoretical values in sign only but not in magnitude.

26. The First minimum in the Intensity of Light Scattered by small Liquid drops and the drop-size.

M. M. Paranjpe *and* M, V. Shingre, Bombay

On the electromagnetic theory of scattering of light developed by G. Mie calculations of intensities of scattered light are worked out for a definite size of the scattering particle of liquids of refractive indices varying from 1.33 to 1.63. These calculations reveal the presence of a sharp minimum in the intensity of the scattered light in the vicinity of the transmitted beam. The angle of scattering at which this minimum occurs almost coincides with the angular radius of the dark corona ring of the first order formed by diffraction of light through the cloud of liquid drops. Hence the first minimum in the scattered intensity may be used as a measure of the drop size if the scattering angle at which this minimum occurs is experimentally determined by measuring intensities of scattered light in the forward direction.

27. Studies in Colloid Optics.

P. K. Katti, Poona.

Change of size and shape of colloidal starch particles in a soluble starch sol at different temperatures has been studied by the light-scattering technique of R.S. Krishnan by using a pair of double image prisms.

Changes in intensity of the transversly scattered light have been measured by an electronic photometer.

The following results have been obtained.

The starch sol contains particles of very small size ($r << \lambda$) at 100°C.

Intensity and depolarisation values remain constant up to 35°C if the sol is slowly cooled below 100°C.

Below 35°C the intensity and depolarisation measurements show the gradual increase in the size and anisotropy of the particles till a constant maximum value of the size is reached in a weeks tme. The final maxmum size increases with decrease in the temperature up to 20°C.

However on reheating a turbid sol it was found that the orginal intensity and deploarisation values are not retraced. Instead they persist upto 65°C above which they rapidly fall off to the original sol values.

5. Electronics

28. A New Method of Determining Thermionic Constants.

S. B. L. Mathur, Lucknow.

A new method of determining Thermionic Constants has been developed under the guidance of Sir K. S. Krishnan in the Physics Laboratory of the University of Allahabad. The metal under investigation is taken in the form of a hollow cylinder closed on all sides except for a small hole at one end. When such a cylinder is heated to different temperatures in vacuum by being enclosed in a graphite furnace tube fed with heavy electric currents from a transformer the electrons emitted by the inner surface of the cylinder soon acquire an electronic gas pressure in equillibrium with the emitting surface. On account of this pressure the electrons effuse out through the hole and those lying within the cone formed with the hole as apex and the diameter of the diaphragm of a Faraday Cylinder kept a few mms. in front of the hole as base are collected by the Faraday Cylinder. From the effusion current at different temperatures the thermionic constants are calculated. This method has some distinct advantages over the usual Richardson type of experimental investigations.

29. Intensity of Electrical pulses of highly damped sinuous type in high frequency channels:

S. R. KHASTGIR *and* ASIT SEN, Banaras & Calcutta.

The effect of a highly damped sinusoidal electrical impulse on the receiving circuit consisting of inductance, capacity and resistance was examined theoretically by E. B. Moullin and L. B. Turner. The analysis showed that the voltage developed across the inductance consisted primarily of a high frequency term corresponding to the natural frequency of the circuit, the low frequency term involving the *quasi*-frequency of the impulse being negligibly small. Considering only the high frequency term, the voltage across the inductance was shown to be inversely proportional to the frequency to which the receiving circuit was tuned. The Fourier analysis by Burch & Bloemsma of a highly damped sinuous pulse, on the other hand, showed that for frequencies much greater than the *quasi*-frequency of the pulse, the amplitude of the particular Fourier component would be inversely proportional to the square of the frequency to which the receiver would be tuned.

To test the validity of the theoretical deductions, experiments were carried out with a H/F amplifier unit which could be tuned to different frequencies within a limited range (170-204 Kc./S) and a Cathode ray oscillograph. The experiments, the details of which are given in the paper, showed that when there was a damped sinuous discharge through an L-C-R circuit, the variation of the H/F voltage developed across the inductance of the circuit with the frequency channel followed the inverse-frequency law rather than the inverse-square law.

30. Periodic Fading or Short-wave Radio Signals

S. R. KHASTGIR *and* P. M. DAS, Benares.

Periodic fading patterns were recorded photographically with Calcutta signals of 4840 Kc/S received at Dacca (distance 240 Km.) during the evening and early night hours of last winter. The main features in the experimental conditions were :—(i) The operating frequency was very much less than the M.U.F. for the F-layer transmission, (ii) the frequency was slightly greater than the M.UF. for the ordinary wave transmission through the E-layer and (iii) it was slightly less than the M.U.F. for the extraordinary wave transmission through the E-layer between the transmitting and receiving stations. The following patterns of priodic or rhythmic fading were observed :

(1) *Sinuous fading of comparatively quick period*: This is considered to be of magneto-ionic origin as being due to the interference between the upper and lower trajectory *extra-ordinary* waves in the E-layer, the ordinary waves having passed through the E-layer.

(2) *Periodic or rhythmic fading of comparatively slow period*: According a new theory that has been proposed, the slow periodic fading was caused by the beat-effect between the singly and doubly reflected waves from the F_2-region or between the singly reflected waves from the E-and F_2-regions, the two interfering waves in different directions having suffered different amounts of Döppler change of frequency due to the vertical movement of the ionospheric layer or layers.

The values of the vertical velocity of the ionosphere as obtained from the proposed theory agreed with the observed values.

(3) *Slow periodic fading with superposed ripples*: This was observed when the ionospheric conditions were favorable for the simultaneous occurrence of the magneto-ionic type of sinuous fading and the Döppler-beat type of slow periodic fading.

The investigation showed that quick random fading was only occasionally observed with 4840 Kc/S signals. The intensity distribution in quick random fading was found to be different from the Rayleigh distribution. There was also evidence of extremely high frequencies (4-12 cycles/sec.) in a few patterns of periodic fading, the origin of which is unknown.

31. The instalation and operation of 10 Cm Radar.

JUGAL KISHORE, Delhi.

A 10 cm Radar set with peak power of 350 K.W. has been set into operation. Several interesting features of the equipment are discussed. The initial difficulties in its operation and the manner of overcoming them are also described.

32. Reflection from Tropospheric layers at 10 Cm.

JUGAL KISHORE, Delhi.

Preliminary results on the sounding of the troposphere to investigate the existence of reflecting layers are presented. By using a high energy pulse (350 K.W.) at 3000 Mc/s, radiated vertically upwards, it has been found possible to record echoes from layers at heights of the order of 1000 to 6000 feet. The possible explanation of this phenomenon are discussed.

6. Ionics

33. Mean Energy of Electrons in H.F. Discharge in H_2

N. R. TAWDE *and* G. K. METHA, Bombay.

The mean energy of electrons in the glow column of h.f. discharge in hydrogen has been measured;by two-independent methods under precisely known conditions. Brasefield's method of estimating the energy by ratio of the intensities of two neighbouring lines in the secondary spectrum of hydrogen, gives values in the neighbourhood of 25 eV. These are much higher as compared to 8 eV. found from probe measurements. Brasefield's general conclusion about the variation of mean energy caused by changing the discharge parameter seem to be true for certain range of pressure and voltage only. The probable sources of error in estimating the mean energy by two methods considered along with the general mechanism of the discharge supports the lower values found by probe measurements.

34. Production of Joshi-Effect in Arsenic Vapour.

P. DAS GUPTA, Banaras.

The above phenomenon has been observed for the first time in arsenic vapour. A siemens' type ozoniser is given a fine coating of arsenic and then evacuated by means of a topler pump. The possibility of the presence of Hg vapour in the ozoniser is removed by inserting a liquid air trap between the ozoniser and the pump. It isfound that no appreciable period of 'ageing' is necessary for the production of the effect. At the threshold potential V_m, the *Joshi-Effect* is about 40% which decreases sharply on increasing the applied potential. The effect decreases in the following order, blue> green>red. An appreciable decrease in *Joshi-Effect* is observed as the supply frequency is increased in the order 50,100 and 500 cycles per second.

35. Spectroscopic study of *Joshi-Effect* in Sulphur vapour.

P. DAS GUPTA, Banaras.

A spectroscopic study of the phenomenon in sulphur vapour was undertaken to determine if the magnitude of the *Joshi-Effect* was independent of selective light absorption. Sulphur vapour in a modified from of siemens' tube was excited by A.C. supply of frequencies 50 and 500 cycles per second. A double diode 80 was used for current detection. A 200 Watt bulb, mercury vapour lamp and hydrogen discharge lamp were used to irradiate the discharge tube longitudnally. At optimum conditions near V_m the relative *Joshi-Effect* observed was 65%, 70% and 15% respectively.

The absorption spectrum of the sulphur vapour in the normal and in excited states was then studied witha quartz spectroscope using electric bulb, mercury arc lamp and hydrogen discharge lamp as sources of light. No difference could be found in the absorption spectrum of excited and unexcited gas in all the three cases.

36. Production of *Joshi-Effect* under X-rays in Arsenic vapour.

P. DAS GUPTA, Banaras.

Production of *Joshi-Effect* using X-rays as the source of irradiation has been reported earlier. In the present case use of X-rays as a source of irradiation for production of the *Joshi-Effect* in arsenic vapour reveals interesting results. Thus it is found that when the tube is irradiated with soft rays (55 kV) positive *Joshi-Effect* is obsrved at all the potentials. On using hard rays (65 kV) as the source of irradiation negative *Joshi-Effect* is observed at the same potentials.

37. *Joshi-Effect* in Sulphur vapour in L.F. and H.F. components of the total discharge current.

P. Das Gupta, Banaras.

The present work is a continuation of the work previously reported on the *Joshi-Effect* in sluphur vapour where the influence of different factors *viz.*, temperature, X-rays, light frequencies in the total L.T. current had been investigated. The results now being reported refer to the influence of different factors on the L.F. and H.F. components of the discharge current in sulphur vapour. (i) An iron core inductance which preferentially admits L.F. component ($i_{L.F.}$) in $i_{L.T.}$ and inhibits $i_{H.F.}$, the latter being by-passed to earth by using a condenser which comparativey impedes L.F., and (ii) a condenser connected in series with the L.T. whch admits the H.F blocking the L.F. component, are used for the expermients. The magnitude of *Joshi-Effect* in different components varies in the following order H.F.> L.T.> L.F. This result is in accord with previous findings.

38. Studies of the Joshi Effect in chlorine under ozonizer excitation—Influence of temperature.

K. S. Visvanathan, Benares.

The influence of temperature, varied in the range 8-67°C, on the magnitude of of the *Joshi-Effect* in Cl_2 taken in the pressure range 55.5—390 mm and excited in a Siemens' ozonizer due to potentials (6.68—13.35 kV) of 50 cycles frequency has been studied. The magnitude of both the net as well as the relative *Effect* decreases with increase of temperature ;,the influence of the applied potential is to increase the net *Effect* and decrease the relative *Effect*. The inhibitive influence of temperature is more pronounced at lower than at higher applied potentials.

39. Production of *Irreversible Joshi-Effect in* (N_2+3H_2) mixtures

K. S. Visvanathan, S. V. Muthuswami *and* R. Krishnamurthy,
Benares

Results for the potential variation of the *Joshi-Effect* in $(N_2 + 3H_2)$ mixtures obtained as the final decomposition products of NH_3 in the silent electric discharge show that the *Effect* is of a much larger magnitude and is obtained over a longer range of pressures (30-420 mm) than in pure NH_3. The *Effect*, maximum at V_m, falls off rapidly, almost precipitously, with increase of applied potential. The *Effect* is maximum (80%) at 272.5 mm of the mixture.

An apparently anomalous *Joshi-Effect* was observed in the system at high pressures *viz.*, 230-420 mm. At these pressures, the system which gave the normal *Joshi-Effect* behaved abnormally when the applied potential reached a certain value; the conductivity of the system, though it decreased on irradiation, did not regain its original value on shutting off the incident light. This *irreversible Joshi-Effect* persists over a potential range which is the larger the higher the pressure of the gas. At potentials above the upper limit, the system once again regains its capacity to show the familiar reversible *Joshi-Effect*. The range of applied potentials in which the irreversible Effect is observed is extended by lowering the temperature of the system; above 30°C this phenomenon is not observed.

40. Investigation of *Joshi-Effect* in Chlorine from the standpoint of heat dissipation in the system.

K. S. Visvanathan, S. V. Muthuswamy *and* R. Krishnamurthy,
Benares.

Arising out of Prof. Joshi's preliminary observations, production of the *Joshi-Effect* in Chlorine has been investigated from a new standpoint viz., the rate of heat dissipation in the system when the ozonizer is (a) in the dark and (b) under irradiation.

Chlorine at a pressure appropriate to giving about 40% *Joshi-Effect* was excited in a sealed Siemen's Ozoniser at 6.41, 6.68 and 6.95 kV of 50 cycles frequency. The rate of rise of temperature of the system was measured by means of a sensitive alcohol thermometer enclosed in the annular space of the ozonizer. It is found that the rate of heat dissipation in the system is appreciably greater in dark than under light when the conductivity of the system is lower. This indicates that the chief seat of the *Joshi-Effect* may be considered to be in the ohmic part of the conductivity as distinct from the displacement components thereof.

41. Potential-Variation of the Ozoniser-Impedance in the Production of Joshi-Effect.

B. N. Prasad *and* B. B. Prasad, Benaras.

Production of *Joshi-Effect* Δi under ozoniser discharge was studied in gases and vapours at various applied potentials V of 50 cycles frequency. By the values of current in dark i_D and under light i_L, the impedance of the ozoniser circuit in dark $Z_D = \frac{V}{i_D}$ and under light $Z_L = \frac{V}{i_L}$ were calculated at various V. A scruitiny of these results along with 200 published and much larger unpublished results in excited chlorine, bromine, iodine, oxygen and mercury vapour *etc.*, over a wide range of exciting conditions, reveals that the influence of an increase in V is always to decrease Z_L. The quantity Z_D, however, in certain cases shows an increase and in others a decrease, which, in part, has been attributed to the comparative decreases of the gas capacity C_g and the resistance R_g (the inverse of conduction current) which is in paralled to C_g, depending upon the gas pressure. Taking into consideration the equation

$$i = \frac{V}{jL\Sigma f + \dfrac{1}{jC_w\Sigma f} + \dfrac{1}{jC_g\Sigma f + \dfrac{1}{R_g}}}$$

for this ozoniser current (Joshi, *Curr. Sci.*, 1947, *16*, 19-21), it has been shown that an increase in Z_D with V is associated with an increase in Σf, the total number of frequencies generated in the discharge space. Further-more, assuming the influence of light, if any, to be constant on R_g, C_g, C_w, and Σf, it has been shown that the decrease of Z_L with an increase in V can result only from an increase in R_g under light.

42, Influence of Space-Charge on *Joshi-Effect.*

D. P. Jatar, Sangar.

Joshi's Theory (*Curr. Sci.*, 1945, *14*, 175, and *ibid*, 1947, *16*, 19). of the above phenomenon postulates: (*a*) photo-electric emission from a boundary layer (*b*) characterised by a low work function, as the first stage leading to *positive Joshi-Effect* ($+\Delta i$), if free from secondary changes; (*c*) the *negative Joshi-Effect* is attributed to negative ion formation due to capture by excited particles of electrons from (*a*). If it be assumed (*d*) that the density of the positive space-charge increases with the applied V; and that it favours $+\Delta i$, and (*e*) the work function is affected by the magnitude and *sense* of the surface field intensity, a consistant explanation is obtained for the results of an exhaustive investigation on the production of $\mp\Delta i$ in chlorine under sleeve excitation by (1) A.C. and (2) D.C. potentials; in the presence of an axial wire which was (3) floating, (4) earthed directly, R = 0, (5) earthed through R varied from 0.25 to 1.0 M Ω, and (6) when R was capacitatively bypassed over the range 0.02 to 0.0002 μf. Results under (1) and (2) were varied by terminal reversal, leading to a large relative increase of the H.T. electrode surface.

43. Production of the *Joshi-Effect* in the Infra-red

S. R. Mohanty *and* Satya Prakash, Benares.

The present work was carried out in order to investigate by direct observation the producibility of the *Joshi-effect* in oxygen when exposed to the infra-red. A (glass) Siemen's tube containing purified oxygen at 308 mm. Hg. was excited at different potentials V, over 2.26 to 4.26*k*V (r.m.s.) of 50 cycles frequency. A *Joshi-effect* Δi of 63% was observed near the 'threshold potential' V_m with *unfiltered* carbon-arc radiations. When these radiations were filtered through 1 cm. thickness of a 7.5% solution of iodine in carbon disulphide, Δi of 0.6 to 1.4% was observed at $V > V_m$, and is ascribed tentatively to the influence of the near infra-red. With the above filter, light from mid-day sun during summer, as also that from an intense carbon-arc was not perceptible to the eye. At constant V, the discharge current i flowing through the system exposed simultaneously to the infra-red increased with time. Thermometric studies revealed that the above filter out off a part of the heat radiations as well from the arc The filtered heat radiations affected panchromatic films. Head radiations from a 1000 Watt incandescent bulb, the filter being a heavily smoked glass plate, showed no Δi.

44. On the Positive-Negative Inversion of the Joshi Effect with the Intensity of Irradiation.

H. J. Arnikar, Banaras.

The earlier finding of Joshi that the inversion potential for the reversible transition of the positive and negative Joshi effects in potassium vapour is sensitive to changes in the intensity of irradiation, has been extended to other systems, *e.g.*, Cl_2, Se-Se vapour, air and H_2. Under costant potential, the transition $+\Delta i \rightleftarrows -\Delta i$ in these systems has been found to be sharply intensity reversible. For instance, in the system Cl_2 contained in a silver-wire-in glass cylinder under a pressure of 170 mm Hg, and excited at a potential of 4.21 *k*V (50 c.p.s.), a change in intensity from 446 to 452 (arbitrary units), *reversibly* changes the Δi from + 10 to − 20. Similarly in the system Se-Se vapour at a potential of 0.9 *k*V (50 c.p.s.) a change in intensity from 40 to 96 changes the relative Joshi effect reversibly from + 5 to − 8%. Besides these, similar intensity inversions have been observed in air and H_2 for light from both an incandescent bulb and an H*g* lamp by the author, and in the systems N_2 and H_2O vapour by others in these laboratories.

45. Joshi Effect in Solid-Vapour Systems : Part II Te-Te Vapour

H. J. Arnikar, Banaras.

A tellurium coated all glass ozonizer free from Hg vapour was prepared for selenium and it was found possible to induce the Joshi effect in the tube with but a few minutes' aging under discharge. Unlike Se, the Te tube showed only the negative Joshi effect over the entire potential range tried both of 50 and 500 c.p.s. frequency, and both for light from a 200-watt bulb and from a quartz Hg lamp. In fields of 50 c.p.s. frequency and under light from the former source, the relative Joshi effect rises from—50% at 0.80 *k*V to a maximum of—75% at 0.88 *kv* and thereafter diminishes to 18% at 2.00 *k*V. Under light from a quartz-Hg lamp, slightly lower values of the Joshi effect were recorded, the values being −33, −68, and −19% for the potentials cited above, although the maximum value is spread over a longer potential range (0.88 to 1.50 *k*V). In fields of 500 c.p.s. frequency, although the current was some 20-50 times more, the maximum Joshi effect recorded under light from the 200-watt bulb was only −7% occuring at 1.08 *k*V, which diminished rapidly to about −1% at 1.75 *k*V. Unlike in fields of the lower supply frequency, considerably higher values of %Δi were recorded under irradiation by Hg vapour light, the values being −26% at 1.00 *k*V. and—7% at 1.40 *k*V.

46. Joshi-Effect in Solid-Vapour System : Part III Zn-Zn Vapour

H. J. Arnikar, Banaras.

A zinc coated all glass oznizer free from Hg vapour was prepared by the same technque as was used forSe and Te (*Proc. Ind. Sci. Cong.*, 1949 Phys. Sect. Abs. No. 14) and values of the Joshi effect in the system Zn-Zn vapour were recorded for potentials in the range 0.7 to 2.0 *k*V of both 50 and 500 c.p.s. supply frequency and for irradiation by light from both a 200-watt bub and a quartz—Hg lamp As in the case of the Se, and Te systems the %Δi is numerically greater under fields of 50 than under 500 c.p.s being −67 and −16% respectively at the optimum potentials, and for visible light. The corresponding values under light from a quartz-Hg lamp are −70 and −32% showing tha the increase in −%Δ due to this source of light is appreciable only in the case of excitation by fields of 500 c p.s. frequency, which behaviour is reminiscent of that of Te and Se. No positive effect was observed under the conditions examined, thus resembling Te and differing from Se. The Zn-tube also differed from both the Se-and Te-tubes in that no fatigue effects were detected in it even after prolonged excitation.

47. Threshold Frequency for the Production of the Negative Joshi Effect Selenium-Selenium Vapour.

H. J. ARNIKAR, Banaras.

By the technique earlier reported *Proc Ind. Sci Cong.*, 1949 Phys Sect Abs No. 14), values for the Joshi effect were recorded for the system Se-Se vapour produced free from Hg vapour for irradiation by visible light of a 200-watt, 210-volt bulb, monochromatized by Wratten filters Nos. 70-76. Additional values were obtained using a sodium and a mercury lamp together with Wratten filters Nos. 50 and 62. Thus, in all 9 nearly monochromatic sources were used, their transmission peaks being at 4358, 4400, 4900, 5300, 5460, 5700, 5830 6100, and 7000 A. units. The total intensities of the filtered radiation, measured both by a thermopile (Kipps 37) and by a Se photo cell (Megatron), were found to be within the saturation limits for the production of the Joshi effect. The isopotentials for the $-\%\Delta i$ versus the peak transmission wavelength when extrapolated to the zero value were found to meet the wavelength axis in the region 8000-8500A. From this the mean value of 8250A appears to be the threshold wavelength of irradation in the production of the *negative* Joshi effect in the system Se-Se vapour.

48. On the Time Disparity in the Production of the Joshi Effect in Different systems

H. J. ARNIKAR, Banaras.

A persistently one sided disparity in the times for the establishment and the subsequent annulment in *full* of the Joshi effect, which is independent of the detector characteristics has already been reported for the systems Hg vapour and halogens (Arnikar, *Proc. Ind. Sci. Cong.*, Phys. Sect, Abs. No. 16). A similar disparity has been observed in numerous other systems including H_2, Se-Se vapour, and in H_2O and D_2O vapours, the last for irradiation by both visible and ultra-violet light, the heavy water vapour being contained in a quartz ozonizer. As in the systems previously reported, the disparity expressed as a ratio of the time of full recovery of the current on cutting off the light, to the time of suppression in full of the current under light, has been found to vary in the same manner as the $\%\ \Delta i$ for changes in the different determinants as, the potential and frequency of the applied field, the intensity and frequency of irradiation; the temperature and pressure of the system; and the proportion of the H.F. and L.F. components in the discharge current.

An explanation of the time disparity seems to be possible on the view suggested earlier by the author (*Proc. Ind. Sci. Cong.*, 1949, Phys. Sect., Abs. No. 12), that the process of formation of the space charge sheaths responsible for the Joshi effect is almost instantaneous, whereas their subsequent destruction is a slower process, being dependent on the kinetic-molecular and -ionic agitations against them. The observed decrease in the time disparity with an increase of temperature, pressure, potential, and frequency of the discharge are consistent with this view of the origin of the Joshi effect.

49. Inversion of *Joshi-Effect* in Iodine Vapour

M. V. RAMANAMURTI, Banaras

Exhaustive studies both in full—and semi-ozoniser type discharges on *Joshi-effect*, Δi in iodine vapour have shown that the *inversion* can also be affected at constant V and t with a variation of the corresponding light intensity I or light frequency ν. Positive *Joshi-effect* $+\Delta i$, near V_c, increases rapidly with I to a maximum value with a slow decrease threafter, finally passing over into $-\Delta i$. Thus *e.g.* at 300 V (20°C), $\%\Delta i$ was $+148$(I=5), $+272$ (I=80), $+42$ (I=1000) and -17 (I=1700); with the *inversion* at I=4500, which corresponds, therefore to the *critical inversion intensity* values I_c. At potentials slightly above V_m, the *effect* Δi, was negative under blue; passed over, under green, to $+\Delta i$ which increased further under red, the corresponding light intensity being constant. Thus *e.g.*, at 306 V (20°C), $\%\Delta i$ was -23 blue, $+6.5$ (green) and $+29$ (red). This was shown to be repeatedly reversible, and hence the *inversion* to occur at a frequency (ν_c) above the green which is, therefore, the *critical inversion frequency.* Existence of V_c, T_c, I_c, and ν_c simply indicates Joshi's generalisation of a simultaneous occurrence of both $+$ and Δi, the greater in magnitude depending upon the operative conditions, determining the sign of the net *effect* Δi.

50. Production of *Joshi-Effect* in Nitrogen

M. V. Ramanamurti, Banaras.

From very limited studies at gas pressures 'P' 26 and 45 *mm* Hg, the occurrence, (upto a maximum of 3%) *Joshi-effect* in nitrogen was reported. Exhaustive investigations in nitrogen, now made, showed that under optimum conditions, *viz.*, $P_{N_2} = 19$ *mm* Hg at 20°C, at V_m, the *effect* is nearly 96% photo-diminution of i. Nitrogen gas pressures $>$ 25 and $<$5 *mm* Hg (20°C) are found to be unfavourable for Δi and this probably is responsible for the low value of Δi already reported. Increased temperature t, applied potential V and the supply frequency, decrease the *effect*$-\Delta i$ in nitrogen; while ght intensity I and light frequency, increase it. A rise in t, deconditions and depolarises the activated boundary layer responsible for $-\Delta i$; hence the decrease with t of the latter follows. The *effect* is maximum near V_m, and decrease thereafter. Thus *e.g.*, at $P_{N_2} = 22$ *mm* Hg (20°C), $\%\Delta i$ 58 at 1.6 kV ($=V_m$) is decreased to 12 at 4.05 kV.

51. Comparative Production of *Joshi-Effect* in Ordinary and Heavy Water Vapour

N. Atchuta Ramaiah, Benares.

Potential variation of the *effect* Δi at different H_2O vapour pressures p varied in the range 3-32 mm. Hg was studied in a Siemen's type silica ozoniser. Experiments were repeated with D_2O vapour contained in the same ozoniser (after complete removal of H_2O vapour). It was interesting to note that as observed in H_2O vapour, an appreciable *Joshi effect* $\pm\Delta i$ was detected in D_2O vapour. The influence on Δi of applied *k*V and of vapour pressure p was in agreement with the general finding due to Joshi. Further, there was no marked difference between the data obtained in the two experiments. Thus *e.g.*, at 0.6 *k*V positive *Joshi effect* $+\Delta i$ corresponded to 23% and 20% current increase in H_2O and D_2O vapours ($p = 15$ mm. Hg) respectively; the negative *effect* $-\%\Delta i$ at 0.88 *k*V was 32.3 and 32.6. By a pressure rise of 17 mm., the values of $-\%\Delta i$ decreased to 13.5 and 14.1. The like behaviour of Δi observed in H_2O and D_2O vapours in respect of potential variation throughout the pressure range investigated and especially of having the same optimum pressure *viz.*, 15 mm. Hg, might be due to the identical extra-nuclear-electronic configuration of H_2O and D_2O.

52. Influence of a series and parallel connected ozonizer on the production of *Joshi-Effect.*

B. R. Marathe, Banaras.

The experiments carried out with a spark gap in the circuit were extended by replacing the spark gap by an ozonizer. When two ozonizers of different sizes and containing different gases were connected in parallel, their respective values of V_m were the same as those when excited seperately. *Joshi-Effect* was sensibly smaller on irradiating either of the ozonizers than when both were irradiated. As observed from the wave form on the Cathode Ray oscilloscope, there were two groups of H.F.s intermixed characteristic of the respective currents in the two ozonizers. Irradiation of one of them reduced the amplitudes of one group of H.F.s while H.F.s in both the groups were reduced in amplitude when both the ozonizers were exposed to light.

53. Influence of a serial spark on the production of Joshi effect.

B. R. Marathe, Banaras.

Joshi-Effect markedly depends upon the value of the applied potential and its frequency. When the spark gap was included between the H.T. terminal of the transformer and the ozoniser it was observed that the spark started first and the ozoniser discharge at a higher voltage. V_m, the threshold potential of the ozonizer was increased with the spark in series. Depending upon the spark width the voltage drop across the spark gap varied and this changed V_m which was never less than the sparking voltage. Within the range of the sparking voltage and V_m there was no effect of light on the current. At V_m and higher voltages there was small *positive Joshi-Effect,* upto 10%. At these voltages in the absence of the spark gap as much as 60% *negetive Joshi-Effect* was observed. It is likely that when the spark is introduced in the circuit, the voltage across the ozonizer is insufficient to maintain a steady conductance, the case being similar to the ozonizer below V_m and without a spark gap.

When, however, the spark gap was included between the ozonizer L.T. and the detector, the glow in the ozonizer appeared at V_m with a sudden increase in current. *Negative Joshi-Effect* was observed above V_m upto the sparking voltage and persisted as long as the spark was unsteady. With increase in voltage the spark became steady, the current due to it was large and no effect of light was observed

54. Production of Irreversible positive *Joshi-Effect* in Chlorine below V_m

B. R. Marathe *and* S. S. Bommannavar, Banaras.

Over a large range of voltage below V_m the initial current was small and unaffected by light. At voltage V'_r, less than V_m, the threshold potential the current in dark increased on irradiation and was accompanied by short H.F.s at the peaks of the sine wave. On shutting off the light the current increased to a still higher value with larger H.F. amplitudes. This *irreversible positive Joshi-Effect* was observed within a range $V'_r - V_m$. The increase in current on irradiation depends upon the intensity of light the increase being more with lower intensity.

The current was small and unaffected by light upto V'_r (1.19 *k*V). At 1.19*k*V the current in dark was zero and increased to 2 units on irradiation. On shutting off the light it further increased to 6 units. The voltage was reduced to zero and increased to 1.23V, when the above effect was observed. This is repeatable, *ad libitem* at various voltages upto V_m (1.27*k*V) when the current increases suddenly even in dark

It is interesting to note that the value of the currnt obtained within the range, $V'_r - V_m$ on irradiation and then cutting off the light is the same as that obtained by decreasing the voltage below V_m irrespective of the frequency and intensity of the light.

55. Production of irreversible *Joshi-Effect* in Chlorine in the hysterisis range below V

B. R. Marathe *and* S.S. Bommannavar, Banares.

With the increase in potential applied to the ozonizer the current was initially of small value i_1 and increased suddenly at V_m, the threshold potential. At this stage the high frequency components were observed with a Cathode Ray Oscilloscope. With a decrese in the potential below V_m the current and H.F.s persisted up to a voltage V_1 due to hysterisis. The *Joshi-Effect* increased gradually below V_m and was almost 100% at and below V_r and upto V_1. It is in this range, $V_r - V_1$ that *Joshi-Effect* is irreversible. The current decreased to the value i_1 and H.F.s disappeared on irradiation and both these were not restored to their values in dark after shutting off the light.

The current at V_m (1.40 *k*V) was 150 units in dark and 55 units in light. On decreasing the voltage upto 1.18 *k*V, the respective current values in dark and light were 19 and 8 units, the effect being reversible. At V_p (1.16*k*V) the current in dark was 18 units and reduced to i_1 (5 units) on irradiation which remained of the same value after shutting off the light. The voltage was increased upto V_m and reduced below V_r when the same irreversible effect was observed upto V_1 (1.12*k*V).

With higher light intensity the current was reduced to i_1 on irradiation at a higher potential and the *irreversibility range* was thus increased. This range increased with frequency of light and was in the order, unfiltered white > blue > green > red, i.e. frequency-wise.

When the temperature of the ozoniser was increased to 90°C, the current below V_m decreased to i_1 in dark, while there was appreciable current on irradiation. Thus, instead of the irreversible effect, a *positive Joshi-Effect* was observed.

56. Studies of *Joshi-Effect* From the Stand Point of Negative Ion Formation

H. S. Nagarajaiah, M. Sanyasi Raju *and* B. B. Prasad,
Benares.

The production of *Joshi-effect* has been explained on the basis of the formation of negative ions and the corresponding space charge. It was, therefore, of interest to investigate conditions where probability for the negative ions is comparatively greater. Two ozonisers evacuated except for mercury vapour saturated at the room temparature were taken. They were (i) in which the bulb containing liquid mercury kept away from the annular space was heated to bring about change of pressure, care being taken to screen off heat radiations affecting the ozoniser. (ii) the other in which the entire system was subjected to temperature variations from 0—80°C.

It was found in (i) that the variation of both i_D and Δi at a constant V was very small and presumably within the range of experimental error. In (ii) the *effect* Δi increased initially to a maximum near the room temperature and then decreased with increase of temperature. This when compared to the variation of negative ions with pressure shows a marked similarity which suggests that negative ions and hence space charge presumably be responsible for the decrease of conductivity on irradiation.

57. Development of *Joshi-Effect* in Mercury vapour

H. S. Nagarajaiah, M. Sanyasi Ralu *and* B. B. Prasad,
Benares.

A detailed investigation shows that long 'ageing' and heat treatment are necessary *only* to extend the effect over a wide range of applied potential. It is now found that about 4 hours of 'ageing' decrease gradually the threshold potential V_m and the conductivity under discharge which are initially high in a Siemen's ozoniser charged with mercury vapour, to a constant minimum, when the effect develops at potentials very near to V_m. The magnitude of Δi is as high as 98%; this decreases very rapidly as the applied voltage is increased slightly and hence the failure of previous workers to detect Δi after comparatively low 'ageing.'

It is seen that the H.F. component though high in the beginning does not have any corresponding Δi but it decreases with 'ageing' to a constant value in about the same period of 4 hours similarly as the total L.T. current and the effect Δi developes. This onset of *Joshi-Effect* only after sufficient 'ageing' and its non-occurence in the beginning even when the H.F. proportion in the discharge current is high suggests that some constant condition such as the formation of a boundary layer as postulated by *Joshi* is necessary for the occurrence of the effect Δi.

58. Production of *Joshi Effect* under X-ray-irradiation in Mercury Vapour.

M. R. Bhiday, Nagpur.

The observation of Joshi, (current Science, 13. 278, 1944) about the instantaneous, steady and reversible current decrease Δi in an ozoniser containing chlorine, subjected to A.C. discharge and irradiated by X-rays was a very significant result considering the powerful ionising property of x-rays. This investigation is now extended, for the first time, to the mercury vapour.

The experimental set-up is the same as in Joshi's note (loc. cit) except that an R.C.A. 30 triode was used as a diode rectifier in the detector circuit, instead of a vacuo-junction. Radiator type Coolidge tube with W Tungsten target was used as the source of x-rays. (general radiation).

The decrease Δi_x on x-ray irradiation is found to vary smoothly with the hardness and intensity of the rays. Thus e.g. at a potential of 6.8 kV applied to the inner electrode of the ozoniser $v\%\Delta i_x$ increased from 2.6 to 25.2 with hardness. Variation of — % Δi_x with intensity as measured by the tube current gave a peak value.

59. Studies in the change in Silent Electric Discharge-current under an Electrostatic Field. Part I

M. R. Bhiday, G. V. Asolkar *and* V. G. Bhide, Nagpur

An *analogue* of "Joshi-Effect" under electrostatic Field is now established. This analogous effect now reported is unique and not described, so far known to the authors in the literature of this discharge phenomena.

The diphenyl oxide vapour in an ozonizer is excited in the range 1.6 KV to 6.4 KV, and then subjected to a uniform electrostatic field. An instantaneous, steady and reversible change in the discharge current (Δi_s) is observed. The discharge current passed through a Bell transformer coupled to a diode R.C.A. 30, is measured by a reflection type sensitive Galvanometer.

The $-\%\Delta i_s$ at a certain voltage is found to increase with the E.S. Field—then declines after reaching a peak—ultimately changes sign and becomes $+\ \%\ \Delta i_s$. Thus at 2.2 KV the $\%\ \Delta\ i_s$ varies from -10.3 reaching a maximum value of -14 then decreases, and finally after reversing the sign gives the value $+\ 13.8$—as the electrostatic field is gradually increased.

60. Studies in the change in silent Electic Discharge current under an Electrostatic Field in Mercury vapour. Part II.

M. R. Bhiday, V. G. Bhide *and* G. V. Asolkar, Nagpur.

An analogue of Joshi-Effect under electrostatic field is now observed.

The Siemen's type ozoniser filled with pure mercury vapour which was subjected to silent electric discharge was kept in uniform E.S. Field. There was observed an instantaneous, steady and reversible change Δi_s in current.

The percentage of Δi_s was found to depend upon the strength of the Field (E.S.). The decrease in current observed as $-\ \%\ \Delta\ i_s$, at a certain voltage; for lower E.S. field strength, was found to increase with the increase in the E.S. Field—and declined after reaching a peak and ultimately changed sign and became $+\ \%\ \Delta\ i_s$. Thus at 1.6 KV applied potential $-\ \%\ \Delta i_s$ changed from -50, reaching a maximum of -59.8 and diminishing to zero—rose further to $+\ 30$.

61. Studies in the change in Silent Electric Discharge-Current under magnetic Field in Mercury Vapour.

M. R. Bhiday, V. G. Bhide *and* G. V. Asolkar, Nagpur.

An analogue of 'Joshi Effect' in the magnetic field is described.

The Siemen's type of ozoniser filled with mercury vapour, through which silent electric discharge was passed was placed symmetrically between the poles of an electromagent, giving a uniform field. The discharge current, after rectification through an R.C.A. 30 triode used as a diode, was passed through a sensitive reflection galvanonometer—measuring the current by the lamp and scale method.

As soon as the magnetic field was put on, the discharge current changed. This change in the discharge current, called Δi_m was found to be spontaneous, steady and reversible. $-\ \%\Delta i_m$ was found to decrease with the increase in the magnetic field-strength. Thus at a certain applied potential, a transition from $-\ \%\ \Delta\ i_m$ to $+\ \%\ \Delta\ i_m$ could be observed by increasing the strength of the field. For instance, a representative reading at 1.6 KV, $\%\Delta\ i_m$ in one direction of the field varied from -58.8 to $+\ 152.5$ while in the other direction, with similar variation of field, $\%\Delta\ i_m$ changed from -35.3 to $+\ 182.2$. Further significant observation that $\%\Delta\ i_m$ depended upon the *direction* of the magnetic field has been established.

The *quenching* of the Joshi-Effect, obtained either by white light, or by x-rays, (described by Joshi, current sci. 13, 278, 1944) and further by Bhiday, M.R. and Asolkar, (unpublished data) and by properly adjusting the magnitude and the direction of field has been established.

62. *Joshi-Effect* in Hydrogen

H. J. Arnikar! *and* V. V. Agashe, Banaras.

By employing a Siemen's ozonizer of total electrode surface, about 1200 sq. cm. it has been possible to obtain large % Joshi effect, (both + and −) in H_2 under a wide range of pressures. Beginning with high values of several 100% in the pressure range 1−200 mm. Hg, the relative positive Joshi effect diminishes as the potential is increased to the threshold limit whereabout the usual $+\Delta i \overset{\rightarrow}{\underset{\leftarrow}{}} -\ \Delta i$ transition occurs reversibly. In the last critical stage, however, the $+\ \Delta i$ (at least partly) occurs irreversibly (i.e. on cutting off the light the photoincrease does not wholly disappear).

The effect of changing the A.C. input frequency $\%\ \Delta i$ and the effect of increasing the gas pressure were studied. The cathode ray oscillograms revealed that the current structure, which is simple in the dark, develops under irradiation additional lines.

7. General Physics

63. On the Choice of Parameters of Pendant Drop in Surface Tension Measurements:

N. R. TAWDE *and* K. G. PARVATIKAR, Bombay.

By choosing any one or other of the parameters of the pendant drop, calculations of surface tension can be made by the use of established relations. Thus Andreas, Hauser and Tucker have taken the equitorial plane and a selected plane for this purpose. It is also possible to obtain fairly accurate results by obtaining the linear measure of the equitorial plane and the depth of the drop from it and using the tabular functions of Bashforth and Adams and of Fordham. This has been done and results compared with other methods, giving critical discussion as to the experimental errors involved in the adoption of the particular parameters.

64. Performance of Sessile Drop Method in Surface Tension Measurements:

N. R. TAWDE *and* K. G. PARVATIKAR, Bombay.

The case of sessile drop has been considered in relation to the pendant drop. The measureable quantities in the case of sessile drop are h, the height above the equatorial plane and r, the radius in the equatorial plane. An accurate empirical relation of h/r with a^2 the capillary constant has been drawn up by Taylor and Alexander to bridge the gap between Porter's values and Bashforth and Adam's tables. In this paper use is made directly of B. and A.'s tables to obtain the quantities involved in the derivation of the capillary constant and hence the surface tension. In the light of the results, sources of uncertainties in the tabular quanties and in the experimentally measurable quantities are critically examined.

65. Surface Tension of Milk and its Dilutions.

L. D. MAHAJAN, Patiala.

It has been found that the surface tension of milk varies with the addition of water in it. The greater is the quantity of water mixed with it, the greater becomes its surface tension. The relation is not so simple and rectilinear but is as follows:—

$$T_s = 54 + \left(\frac{m}{100}\right)^2 \times 20$$

Where T is the surface tension of the milk, and m is the % water in the milk. This equation gives quite satisfactory results.

The effects of various impurities, such as starch, sugar, flour, etc. have also been studied.

The practical use of this discovery has also been discussed in detail.

66. The Air flow Method of Measuring the Specific Surface of Jute.

M. M. ROY *and* M. K. SEN, Calcutta

An apparatus for measuring the specific surface of jute has been constructed. The specific surface of jute as obtained from measurements by using the air flow method is ca 1000 cm^2/cc, which agrees with the value derived from microscopic measurements. The value of the proportionality factor K of the Kozeny equation employed for the purpose is 5.17, being higher than the values for cotton, wool, etc., but coincides with the value for granular beds, such as, sands, cements, etc. The cause of the high proportionality factor for jute is under further investigation.

67. A Note on the Specific volume and the Porous Structure of Jute.

M. K. SEN

On the basis of Hermans' theory and using the specific volume figures for jute due to Macmillan and Sen, and those for pure cellulose fibres as given by Hermans, some deductions have been made about the porosity of jute fibres. The true specific volume of jute is 0.696 cc/gm against 0.645 cc/gm for cotton or ramie, and the difference is not due to lack of penetration of solvent (carbon tetrachloride) in the lumen area. The only explanation that can be put forward is that the solvent penetrates the lumen but fails to do so into some other void spaces in jute. The fact that water penetrates these spaces is indicated from the figure for the specific volume of jute in water, 0.641 cc/gm. It appears, therefore, that the void space in jute is composed of hydrophilic structure. In the case of rayon, Hermans has shown that the specific volume is related to the proportion of amorphous cellulose. Comparing the excess volume (relative to cotton) per 100 gms of jute, 5.1 cc with that of rayon, 1.6 cc, it can be seen that the void space is much greater than that in rayon. Since the proportion of crystalline cellulose in jute is about the same as that in rayon as shown from the background analysis of the X-ray diagram by Sen and Hermans, the cause of the extra space should be sought in some other factor besides amorphous cellulose. Lignin in combination with hemicelluloses may provide such open structures located, perhaps, in the region including and bordering the middle lamella. Some such indication is already obtained in the X-ray and microscopic studies of jute.

68. Suction and Compression by Lungs.

D. V. GOGATE *and* G. Z. SHAH, Baroda.

In this paper the action of human lungs is compared with that of the ordinary suction and compression pumps. Two simple experiments are described, one in which lungs are used for sucking in air from a large flask and the other in which they are used for compressing air. The results of these experiments clearly show that the usual formula for the pressure (or density) of air in the receiver of an air pump after a certain number of strokes of the piston, is completely verified in the case of lungs also.

69. Thermo Electromotive Force in single Crystals of Molybdenite

AJIT KUMAR DUTTA, Calcutta

An account of the measurements of the thermo-electromotive force of copper-Molybdenite-copper couple from room temperature to a temperature of about 200°C is reported. The molybdenite sample was a long single crystalline flake of sufficient thckness. Within the range of temperature the thermo e.m.f. per degree $\frac{dE}{dT}$ has been found to be practically constant and this is also the case in the lower temperature range. Moreover, $\frac{dE}{dT}$ is very high—higher than in usual metals and this indicate as useful clue to the construction of a low-temperature thermo-couple.

70. The Vibration of a circular membrane Symmetrically loaded at the Centre.

K. C. KAR *and* B. N. BOSE

In the present note the problem of vibration of a circular membrane symmetrically loaded at the centre has been studied. Two special cases have been considered —(1) when the load is a circular plate of uniform thickness and (2) when the load is a spherical ball. The frequency-equations for the loaded membrane in these two cases have been derived.

71. Theory of Consistency of Soil

S. P. BAIDYA, Calcutta.

When water is added to dry pulverised clay soil and the mass is mixed thoroughly, the mass passes from cohesive solid to plastic then to fluid state. Applying the idea of film formation among the particles and taking into account the weight of particle and its surface water the force of tension between two particles in the direction θ to the horizon may be represented thus

[illegible] $= 4\alpha - \left\{\left(\frac{\rho_1}{3}\gamma_1 + \quad\right) + \left(\frac{\rho_2}{3}\gamma_2 + l_2\right)\right\}$ Sin θ where α is the force per unit area with which water adheres to the surface of a soil particle α depends on chemical nature of particle surface and the viscosity of water $\rho_1, \rho_2, l_1, l_2, \gamma_1, \& \gamma_2$ are the densities, the thickness of water films and radii of the two particles (assumed to be spherical). When $\rho_1 = \rho_2 = \rho; \gamma_1 = \gamma_2 = \gamma; t_\theta = 8\left[\alpha - \left(\frac{\rho}{3}\gamma + l\right)\text{Sin }\theta\right]$ Now if $t_\theta \leqq 0$, $\alpha \leqq \left(\frac{\rho}{3}\gamma + l\right)$...... There are, therefore, maximum limit of the size of the particles which with the minimum thickness of water film will have no force of tension between them.

72. Measurement of the Consistency of Soil

S. P. **Baidya**, Calcutta.

If Q be the quantity of water and x, W_ρ, and W be the dry weight in grams of clay, particles other than clay and soil per c.c. of a plastic mixture then $Q = 1 - \frac{W}{S} =$ $x + U_\rho W_\rho + Qp$ where U_x, U_ρ .. are the quantities of surface water per gram of dry clay and particles other than clay in the mixture s is mean sp. gr. and Qp is free water per c.c. excess over surface water. We have shown in our discussion on the theory of consistency that $l = (R - \gamma)\frac{\rho}{3}$ it may be shown $U = \left(\frac{R}{\gamma} - 1\right)$ where U_ρ l...... all refers to particles in general U_x is positive for cohesive particles and negative for non-cohesive particles, U_x and U_ρ all depend on the force of tension measured by

Further, it may be shown $Q_p = Q_{p0}\frac{1-Q}{1-Q_{p0}}$ where $Q_{p0} = (\beta^3-1)/(\beta^3-1+s)$ β depend on the force of tension, Q_p is the quantity of water per c.c. in the pores, when the film of surface water reduces to zero. Then, $Q = Q_{p0} + (U_x x - U_\rho W_\rho) + (1-Q_{p0})$ or $W_\rho = \left[(1-Q_{p0}) - x(1-Q_{p0})\ U_x + \frac{1}{s}\right] \Big/ \left[\frac{1}{s} - U_\rho(1 - Q_{p0})\right]$

73. "Change of state of Consistency of Soil"

S. P. **Baidya**, Calcutta.

In the disturbed state of plastic soil mass the thickness of water film round the mean particle of the soil is same everywhere over its surface. In the quilibrium condition of the soil mass this thickness in the direction θ to the horizon is $l_0 = l_h\,\rho_0 - \text{Sin }\theta$ ...... and the force of tension in the same direction is $t_\theta = t_h - \left(\frac{8}{3}\rho\gamma_\beta + l\right)\text{Sin }\theta$ ....where $\rho_0 = \frac{l_h}{t_h}\left(\frac{8\rho}{3}\gamma_\beta + l\right)$ l_h and t_h are the thickness of water film and force of tension in the horizontal plane. $t_h = 8\alpha$.... and therefore constant. If R be the distance from centre to the surface of its water film of a particle then the area occupied by the particle and its water film in the vertical to the area in the horizontal plane is $\frac{L_0 - \rho_1}{L_0}$ where $L_0 = \gamma_\beta + l_h$ let $e = \frac{L_0 - \rho_0}{L_0}$ .... Then when e is less than 1 the mass is in the plastic state, when $e = 1$ the mass is in the solid state. Let $R_h = \gamma_\beta + \frac{3}{\rho}l_h$ where R_h refers to the force of tension in the horizontal plane.

Sin $\theta = 0, \left(\frac{8}{3}\rho\gamma_{\beta} + l\right)$ is not zero so R_h is not zero. R_h depend on $\gamma\beta$ and l_h.

So $e = -\frac{l_h}{t_h}\left(\frac{8}{3}\rho\gamma_{\beta} + l\right) \Big/ \left(1 + \frac{\gamma_{\beta}}{R_h - \gamma_{\beta}}\right)$ So e changes with the change of γ_{β} when K_h is constant. Then for the same force of tension the plastic shape of a soil depend on $\gamma\beta$. When $e \underline{\Omega}\, 1$; $e = 1 - \frac{l}{t_h}\left[\left(\frac{8}{3}\rho\gamma_{\beta} + l\right)\left(\frac{R_h}{\gamma_{\beta}} - 1\right)\right]$

This explains the change from plastic to soi state of sandy soil at a very thin film of surface water while the same change of clayl soil at comparitively thick film of surface water.

74. Force of Consistency of Soil.

S. P. Baidya, Calcutta

Now $t_0 = Fl_e$ where $F = \frac{t_u}{l_u}$; F is termed as the force of consistency. It is independent the direction in which the force of tension is measured. Further $t_e = \frac{t_u}{l_u}(R_e\ \gamma_{\beta})\frac{\rho}{3}$

When t_e is maintained constant R_e remains constant. Therefore, change in γ_e causes change in the force of consistency. Thus the force of consistency is independent of the force of tension. The force of tension in a direction θ to the horizon decreases with the increase of R_e irrespective of the changes in the size of the mean particle. Therefore when the force of tension changes with the change of θ, but remains same in the same direction, irrespective of the changes of the size of the mean particle, the force of tension in any direction in a plasticmixture increases as the volume described by the revolution of the arc$R_e = \gamma_{\beta} + \frac{3}{\rho} l_e$....decreases. If V_1 be this volume then

$$v_1 = \frac{2}{3}\pi\left[\left(\gamma_{\beta} + \frac{3}{\rho}\ln\right)^2\left\{2\left(\gamma_{\beta} + \frac{3}{\rho}\ln\right)\frac{9}{2\rho}\cdot\rho_0\right\} - \frac{9}{\rho^2}.\rho^2\left\{2\left(\gamma_{\beta} + \frac{3}{\rho}\ln\right) + \frac{9}{4\rho}\cdot\pi\text{-}\rho_0\right\}\right]$$

V_1 may be termed as elementry zone of tension. The force of tension corresponding to a volume V_1 disappear in a soil when V_1 is smaller than the occupied by its mean particle and its minimum mean thickness of water film

75. Vector hardness of diamond and diamod tools.

P. K. Kichlu *and* Harsh Vardhan, Delhi

The variation of hardness of diamond with the direction of crystal axes though fairly well known has often been incorrectly described. There is thus considerable lack of appreciation of the use of diamond tools in many technical processes in laboratories. It is due to this cause again that misleading statements are sometimes made that from different localities show difference in hardness. A diamond is by for the hardest substance known and its crystals roughly rounded in shape, each point on the surface of diamond must be worked by a unique process. A study of different types of tools which are being used in industry has been made and points which make for the superiority of one type over another are discussed in terms of the vector hardness.

Description of a machine for generating cylindrical surfaces on diamonds is given.

76. On making photographic developers

Mela Ram, Delhi

For spectrographic work, the author had to develop photographic plates and papers at irregular intervals using developers of different compositions. It was found inconvenient to make fresh developers every time. A way has been worked out by which six standard solutions are first prepared. These are such as will keep over long periods. Every solution is given a multiplication factor which determines the volume of the solution required to give the desired percentage of the chemical in a given developer formula.

The method is very convenient and saves a great deal of time otherwise wasted.

77. The change of the Magnetic Anisotropies of Potassium Permanganate with the variation of temperature.

BHAGAVATI CHARAN GUHA, Calcutta.

In potassium permanganate, the manganese atom should have the argon configuration with seven electrons in the 3d shell, and should be diamagnetic. If the atom be regarded as having lost all its seven electrons, and is Mn^{7+} ion, we shoud expect the crystal to be diamagnetic. That the paramagnetic susceptiblity of the crystal is extremely small, corresponding to mean $p^2 = 0.25$, at room temperature, as obtained by A. Mookherji, conforms to this prediction. The fact that there is left over a feeble paramagnetism need not occasion surprise, since the assumption of the presence of the Mn^{7+} ion is only an approximation.

The absolute value of the susceptibility being so small, its temperature variation could not be measured with our experimental arrangement; we could measure only the anisotropies. The anisotropies, $\chi_a - \chi_b$ and $\chi_a - \chi_c$ plotted against temperature give almost straight lines; they increase 2.4 and 1.6 times respectively, as we pass from 300°K to 80°K. It is difficult to estimate how much of the observed feeble anisotropy of the crystal is due to diamagnetism.

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SECTION OF BOTANY

President: Prof. P. Maheshwari, D.Sc., F.N.I.

Cryptogamic Botany and Plant Pathology

1. On the Occurrence of Endospores in Oscillatoria Synopsis.

B. N. Mulay, Pilani.

Endospore formation is rare in Nostocales and still more so in *Oscillatoria*. Endospores have been observed in a species of *Oscillatoria* found at Dudh-Sagar (Gon). There may be one, or two, or four endospores in a cell without any partition walls between them. They are liberated by the cell wall becoming mucilaginous.

2. *On Chlorogloea Fritschii* N.Sp. from Indian Rice-Field Soil.

A. K. Mitra, Allahabad.

Chlorogloea Fritschii N. Sp. formed a deep blue-green crust-like stratum on soil in cultures of desiccated soil samples from rice fields near Allahabad. The life-history of this alga has been studied in uni-algal cultures on both solid and liquid media. The growth consists of large loosely arranged superposed packets of round chroococcoid cells easily visible to the naked eye. Cell division takes place along three planes.

Any cell can produce a single naked endospore which it liberated through a wide irregular opening of the envelope which subsequently collapses and becomes folded. These endospores germinate to give rise to a short, straight or slightly curved filament of three to twelve cells. Subsequently cells of the filament begin to divide along planes at right angles to the first in three directions, obscuring the prostrate filamentous juvenile condition. The relationship of this alga is discussed. It is pointed out that the presence of a prostrate juvenile condition in *Chlorogloea Fritschii* lends support to the derivation of Pleurocapsales from the Entophysalidaceae which was so far doubted by Fritsch due to lack of any evidence of the occurrence of a juvenile filament in the latter.

3. *On Chloranomala Palmelloides* Gen.Et.Sp. Nov. From Indian Rice Field Soils

A. K. Mitra, Allahabad.

The palmelloid colonies of this alga appeared as a thin light green film on the surface of solution in cultures of desiccated soils from rice fields near Allahabad. The alga was grown in unialgal cultures both on liquid and agar media and its life-history studied.

The cells are surrounded by a hyaline mucilage layer and possess a light green parietal chloroplast with a posterior pyrenoid. Starch and a few oil drops are present. The first division in soon followed by the second in a plane at right angles to the first. When transferred to water the daughter cells wriggle out as naked highly metabolic biflagellate swarmers. Meanwhile the starch is mostly converted into numerous globules which give all the tests for oil. These swarmers also behave as facultative gametes. They conjugate in pairs after clump formation and form quadriflagellate zygotes which come to rest, secrete mucilage and divide into four daughter cells.

4. Observations on the Algae of Manured and Unmanured Soils and on the Effect of Different Culture Solutions on their Growth.

Ella A. Gonzalves and Kusum S. Gangla, Dharwar.

This investigation is an attempt to study the effect of manuring on the nature and quality of the algal population in soils as also whether the culture solution used has any effect on algal growth. Liquid and moist cultures were made of soils obtained from Niphad from an unmanured wheat field and from one manured with groundnut cake. No growth was observed in the moist cultures but the same algae were found in the liquid cultures of both soils. To determine the actual number of algae in each sample, counts were made by the dilution method of Skinner. The probable number of algae per gram of soil was found to be almost the same in both soils. Other workers have observed increased numbers of algae in manured soils.

As the moist cultures showed no growth it was presumed that some element necessary for algal growth was lacking in the soils. In order to determine whether the nature of the nutrient solution would affect the nature of the algal flora, different culture solutions viz. Knop's Beijerinclis, Bristol's, Benecke's and Molisch's were used instead of sterile water for preparing the moist cultures. Benecke's and Bristol's solutions were most favourable for algal growth. In the former however, blue-greens flourished, in the latter both greens and blue-greens were found. Liquid cultures of the same soils corroborated the results.

5. Studies in Indian Ricciaceae—I.

Ram Udar, Lucknow.

The present communication includes an illustrated account of the following 4 Indian species of *Riccia* Mich. occurring in Lucknow and its vicinity during monsoon months:—(1) *Riccia discolor* L. et L. (2) *R. dictyospora* Howe. (3) *R. gangetica* Ahmad. (4) *R. melanospora* Kashyap.

This study clearly shows that *Riccia himalayensis* St. (as described by Kashyap in the Liverworts of the Western Himalayas and the Panjab Plains-I) is a composite species embracing *Riccia discolor* L. et L and *R. dictyospora* Howe. The two species differ in (1) habit, form and colour of the thallus, (2) sexuality, (3) spore size and sculpture, and several other taxonomic details.

6. South Indian Hepatics—II.

S. K. Pande and Ram Udar, Lucknow.

An illustrated account of the following seven species from Pfleiderer's collection is given:—

1. *Ptilidiaceae*: (1) *Herberta capense* St. (2) *Herberta pinnata* St.
2. *Radulaceae*: (3) *Radula javanica* G.
3. *Lejeuneaceae*: (4) *Ptychanthus striatus* Nees. (5) *Ptychanthus nietneri* St.
   (6) *Thysananthus rotundistipulus* St., and (7) *Taxilejeunea tenerrima* St.

The species were mostly determined by Stephani and are included in his Species Hepaticarum (Vols. IV and VI), Four of these (1,3,4, and 5) are recorded for the first time from South India. Only *Ptychanthus striatus* Nees has been previously described in some details in publications on Indian Bryology.

7. On East-Himalayan Hepatics—I.

V. SCHIFFNER, VIENNA AND S. K. PANDE, Lucknow.

The following list comprises of 138 species of hepatics representing 45 genera and 20 families collected by Rev. P. Decoly and Schaul from the neighbourhood of Kurseong in the district of Darjeeling varying in altitude from 5000'—7000'.

Determinations were made by V. Schiffner, Stephani and Pande. There are about a dozen new species, about half a dozen new varieties and many new records for the province and the Country. In some cases, *e.g.,* (1) *Megaceros,* (2) *Notoscyphus,* (3) *Jackiella,* (4) *Euosmolejeunea* etc., these represent the first records of the genus from India.

8. Embryology of *Sewardiella Tuberifera* Kash.

P. N. MEHRA AND A. L. KHANNA, Amritser.

The vegetative body of *Sewardiella tuberifera* has saddle-shaped appearance consisting of thick central midrib and two flattened wings. Often the thallus is dichotomously branched.

The older ventral region of the midrib is invariably profusely infected by an unseptate fungal mycelium which is probably in symbiotic relationship with the species. It forms thick-walled vesicles which often fill the entire cavity of the cell. The apical cell is tetrahedral with three cutting surfaces. Apical tubers are the means of perennation during winter.

The plants are strictly dioecious. The antheridia are scattered on the dorsal surface of the midrib, each growing in the axil of a bract but occasionally more may be present in the axil of a larger bract. They originate from the segments of the apical cell and thus are strictly a cropetal. Development is of the usual Jungermanniales type.

The archegonia are aggregated on the dorsal surface of the midrib in the form of a cluster which is surrounded by free bracts on all sides. Younger and other archegonia occur mixed. Development follows the usual Jungermanniales type. The neck is composed of 5-8 rows of cells. Up to nine neck canal cells have been observed. The venter is only one layer of cells thick before fertilization.

The bell-shaped perianth develops by a common basal zonal growth carrying the involucral bracts above, which not only form the lacerated margin of the cup but also occur on the inside and outside of the cup. Strictly the perianth is thus of composite nature.

Mother cells of the spores and elaters belong to the same cell generation. Spore mother cell protoplast is four-lobed and gives rise to spore tetrads by the deepening of the invaginations.

Foot is bulbous of Douin's generalised type with its basal cells haustorial in function. The capsule wall has three to four layers, all showing bands of thickenings on the radial and inner walls. The spores are reticulate lamellate. The elaters are small in size and bi or tri-spiral.

The haploid chromosome number is nine and the diploid eighteen.

9. Prothalli of *Lygodium Japonicum* Sw. and *Aneimia Rotundifolia* Schrad.

T. S. MAHABALE AND H. Y. KULKARNI, Bombay.

The prothalli of *Lygodium japonicum* were obtained both in nature and in culture. The spores germinate readily when fresh but soon loose their vitality. The adult prothallus is formed after about 25 days in culture and consists of a flat heart shaped prothallus with two large rounded lobes. The meristem consists of a few cells at the notch. The cushion is about three cells thick. The embryonic plants are formed in about 40 days. The development of the archegonia and antheridia is normal. The opercular cell of the antheridium is circular surrounded by another eccentric cell. The prothalli germinated in culture were similar to those obtained in nature.

The prothalli of *Aneimia rotundifolia* were obtained by germinating the spores in various culture media and produced a much branched filamentous alga-like prothallus. There are about five branches on the primary filament emerging from the spore, each one having a distinct growing point of its own. The adult prothallus is multilobed and diffuse in form.

A comparative study of the anatomy of *L. flexuosum* Bedd. and *L. japonicum* Sw! showed that the primary underground stem is protostelic in both the species with plenty of pith mixed with xylem. It becomes multi-arched in the vertically growing twining stem, passing through an intermediate anchor-shaped stage having four protoxylem groups arranged more or less in the form of "X" reminding one of the configurations met with in the leaf traces of Zygopteridineae. The leaf trace in both the species comes out as an abstriction of the circular stele. The pinna traces come out marginally from the leaf traces.

10. A Contribution to the Study of the Genus *Cheilanthes*.

T. S. MAHABALE AND J. J. SHAH, Bombay.

The genus *Cheilanthes* is represented by three species in the Bombay Presidency. They are *C. farinosa* Kaulf., *C. Tenuifolia* Sw. and *C. albomarginata* Clarke. For an account of the prothalli of the first two species (see *Proc. 36th Ind. Sci. Congr.*, 1949, Part III, p. 125). The present paper gives an account of the prothalli in *C. albomarginata* growing in the Western Ghats under extremely xerophytic conditions. A comparative account of the anatomy of the three species is also given.

The spores germinate readily, the first division being transverse, giving rise to a rhizoidal and a prothallial cell. One or two rhizoids arises generally from the basal cell. The rhizoids are long and zigzag. The primary filament consists of six to seven cells and is followed by three to four horizontal branches which ultimately form an irregularly lobed prothallus. There is no single apical cell in the prothallus.

A comparative study of the anatomy of the stem showed that the stele in the three species is variable varying from solenostele to dictyostele with two to three overlapping gaps. The leaf trace is single, and is Y-shaped at the base. The two arms of xylem are broadly extended and curved with two protoxylem groups at the ends. The pinna trace is marginal. The anatomy of the leaf shows strong xerophytic characters, particularly in *C. albomarginata*. In this species, among other characters, there is a compact three-layered palisade tissue, not present in the other two species.

11. Germination of the Spores and Adult Prothalli in Culture of *Ceratopteris Thalictroides* Brongn.

T. S. MAHABALE AND S. R. JAVALGEKAR, Bombay.

The prothallus of *Ceratopteris thalictroides* Brongn. has been generally described as unisexual by earlier workers. One of us has already shown that under natural conditions the adult prothalli are hermaphrodite in this species. It was, therefore, thought worth-while to germinate the spores and to see what kind of prothalli are obtained in culture.

The spores germinated readily in Knop's solution and after they had reached a certain stage were transferred to a thin layer of soil spread over bricks watered from below. A very small proportion of the prothalli was small and filiform and bore numerous antheridia near the apical parts ; but a great majority of them were large and formed both antheridia and archegonia. The shape of the prothallus varied from filiform to cordate with symmetrical or asymmetrical lobes. The number of lobes varied from three to four. The archegonia were formed behind the notch and below the meristem. The antheridia were placed marginally or submarginally but in both the cases they were found embedded in the tissue of the thallus. The embryos develop normally. The prothalli in culture are thus either hermaphrodite or male.

12. Cytology of Apogamy and Apospory in *Doodia Aspera.*

P. C. SARBADHIKARI, Calcutta.

Within recent years some light has been thrown on the facts and meaning of sexual fusion and the correlative process of meiosis. But the cyclically recurring events, generally known as alternation of generations, are still vague owing to lack of convincing evidence. Considerations of this kind have attracted the writer to a study of apospory and apogamy with special reference to the cytological aspects of the problem.

The embryo arises apogamously as a direct vegetative outgrowth from the prothallus. Both the sporophyte and the apogamous gametophyte arising from it have the unreduced number of chromosomes. From this it is evident that apospory is balanced by apogamy. When apospory has occurred in the life-cycle, an apogamous development seems the only way of continuing the life-history.

13. Comparative Anatomy of Indian Ephedras.

G. C. MITRA, Calcutta.

In India *Ephedra nebrodensis* Tineo, *E. gerardiana* Wall., and *E. intermedia* Shrenk & Meyer form the source of Ephedrine. The first two species contain about 60 to 70 per cent Ephedrine in the total alkaloids and the last about 10 per cent. The species present very little difference in external characters. Anatomically *E. nebrodensis* and *E. intermedia* present differences in : (1) the nature and development of the fibers ; (2) differentiation of the cortex ; (3) development of mesocortical fibers ; (4) development of secondary xylem from the interfascicular cambium ; and (5) presence or absence of isolated fibers around the inner margin of the xylem strands.

The fibers, in general, are fewer and less lignified in *E. intermedia* and the mesocortical fibers do not form a second series in the cortex. Further, the cortex is differentiated into an outer layer of palisade cells and an inner spongy parenchyma, while such differentiation is not noticeable in the other species. The large amount of secondary xylem produced from the interfascicular cambium obliterates the wedge-shaped character of the primary xylem in *E. intermedia,* while in the other species it is not lost even after secondary growth. In the latter species Isolated groups of fibers are found around the inner margin of the xylem strand while they are absent in *E. intermedia.*

Other species of *Ephedra* are under investigation.

14. The Embryo Sac and the Embryo of *Helixanthera Ligustrina* (Wall.) Dans.

B. M. JOHRI AND P. MAHESHWARI, Delhi.

There are no ovules or nucelli in the usual sense. Several megaspore mother cells differentiate from a mass of parenchyma cells in the centre of the ovary. The basal megaspore functions. The upper part of the embryo sac grows into the style and reaches into the stigma. It shows the egg apparatus (consisting of two synergids and the egg) and the upper polar nucleus. Five or more embryo sacs grow at the same time in a style. The lower part of the embryo sac which remains in the ovary shows the three antipodal cells and the lower polar nucleus.

The first division of the oospore is vertical, followed by a number of transverse divisions resulting in a long biseriate proembryo which continues its growth downwards into the style until it reaches the ovary. Several proembryos grow in the same style and reach the ovary. The endosperms produced by the embryo sacs in their lower part fuse and produce a composite structure, which fills the central portion of the ovary and in which all the descending embryos are embedded. Ultimately only one of the embryos develops further. The downward extension of the endosperm is checked by a collenchymatous pad of cells at the base of the ovary and its further growth is therefore on the margins of the pad rather than towards its base.

15. Intracarpellary Pollen Grains in Trillium.

B. M. Johri and A. M. Eunus, Delhi.

Three species of *Trillium*—*T. erectum, T. grandiflorum, T. sessile* and *T. sessile* var. *giganteum*—have been studied. The tricarpellary syncarpous pistil shows a single loculus in the upper part of the ovary and three loculi in the lower part. The style shows a tri-radiate stylar canal and the stigma lobes have numerous glandular hairs.

The mature pollen grain is two-celled. Pollen grains were seen on the stigma of ovaries having two-nucleate embryo sacs.

The wall of the ovary shows numerous air spaces. Pollen grains have frequently been observed in the wall of the style, aerenchymatous tissue of the ovary wall, and also inside the ovary. A few germinating pollen grains were also seen inside the ovary (*T. grandiflorum*) and in the stylar tissue (*T. erectum*).

Since intraovarial pollen grains were first discovered by one of us in *Butomopsis*, similar pollen grains have also been reported in some other plants. Whether they can bring about fertilisation has not been observed but such a possibility can not be ruled out.

16. A Contribution to the Life History of *Acalypha Fallax.* **Muell Arg.**

I. Banerji, Calcutta.

The development of the microspores is of the simultaneous type. The haploid number of chromosomes is 21 and the tapetum is of the secretory type. The embryo-sac develops in a tetrasporic manner and the mature gametophyte conforms to the *Acalypha indica*-type. Variations in the organization of the mature gametophyte have been recorded.

17. A Contribution to the Life History of *Melochia Corchorifolia* L.

C. Venkata Rao, Waltair.

Tapetum is of the plasmodial type and develops from the innermost layer of the five cells thick another wall. Microspore tetrads are tetrahedral and cytokinesis is by furrowing. Mature pollen grains are spherical, smooth-walled, 2-nucleate and show three rectangular germ pores.

Archesporium of the ovule is multicellular though only one cell functions usually. The chalazal megaspore of the linear tetrad forms the 8-nucleate embryo sac.

Fertilisation is porogamous. The triple fusion nucleus forms the endosperm which is nuclear in the beginning and becomes cellular later.

Embryo development corresponds to *Asterad*-type. The fertilised egg divides transversely. The apical cell divides longitudinally and the basal cell transversely. The penultimate cell divides again transversely and the embryo develops from the three terminal cells, the lowest remaining as a 1-celled suspensor. The terminal tier forms stem tip and cotyledons ; the second cell gives rise to hypocotyl and the third to the root tip. The suspensor cell cuts off a hypophysis cell which fills out the dermatogen of the root tip and root cap.. The embryo is straight and its cells like those of the endosperm get filled with starch grains.

The outer integument forms a membranous cover ; the outermost layer of the inner integument develops into the palisade layer.

18. The Embryology of *Dendrophthoe Falcata* (Linn. fil) Ettingshausen.

Bahadur Singh, Agra.

Floral parts arise in acropetal succession, i.e., the calyculus appears first and is followed by the perianth, androecium and gynoecium. The vascular supply of the flower is based on a pentamerous plan, their being no traces to the calyculus. One bundle enters each perianth lobe and divides into three to five strands. The stamens also receive a single trace. The remaining five bundles enter the style and may divide to form as many as ten bundles in the stigmatic region.

Microsporogenesis and the development of the male gametophyte follow the usual course. Pollen grains are shed at the bicelled stage. The generative cell divides after it has travelled an appreciable distance in the pollen tube and shows clear spindle fibres accompanied by cell plate formation resulting in two oval male cells.

Megasporogenesis and development of the female gametophyte show several interesting features. The archesporium originates in the hypodermal layer at the base of the ovarian cavity. Several layers of cells below the archesporial tissue and near the base of the ovary there is a pad of collenchymatous cells.

The tetrads of megaspores are of the linear type. Anyone or more of the megaspore of a tetrad, excepting the topmost, may function.

On account of the gliding growth of the megaspores and the resultant gametophyte the ovary cavity gradually becomes obliterated.

The mature embryosac is greatly elongated. It has a normal egg apparatus and the upper polar nucleus in its upper end, and three ephemeral antipodal cells and the lower polar nucleus at the lower end.

Further elongation of the embryo sac continues at both ends, following a meandring course which is often very pronounced in the ovary. The antipodal end of the embryo sac finally reaches down to the pad of collenchyma, while the upper swollen end, containing the egg apparatus, enters the stylar canal so that the two ends may be 22-28 mm apart in a straight line. As many as eight to ten embryo sacs may be seen in the stylar canal.

The endosperm is of the cellular type and begins development in the lower part of the sac. As soon as one of the embryos, growing downwards from the style, touches the pad of collenchyma endosperm cells divide rapidly. Finally owing to a dissolution of the separating walls of the embryo sacs all the endosperms fuse to form a composite mass containing the embryos. The first division of the fertilised egg is longitudinal and later divisions are transverse resulting in a long biserate suspensor. As the pro-embryo grows down the style there is another longitudinal division in the two terminal tiers resulting in a row of four cells at the apical end, the rest of the pro-embryo remaining biserate. No further longitudinal divisions take place until the pro-embryo has reached the pad of collenchyma. As a rule only one embryo reaches maturity while the others degenerate. On account of the subsequent fusion of the two cotyledons the mature embryo appears to be monocotyledonous. Its radicle end protrudes outside of the endosperum while the rest is embedded in its tissue.

The fruit is a pseudo-berry and has a characteristic viscid layer which brings about the ejection of the seed.

19. Behaviour of Antipodals in the Embryo Sac of *Fumaria Parviflora.*

H. B. SAKSENA, Gwalior.

The mature embryo sac is eight-nucleate and shows an egg apparatus (consisting of two synergids and and egg), the upper and lower polar nuclei, and three antipodal cells. The latter show a very abnormal behaviour which is reported here.

Soon after the egg apparatus has been organised, the antipodal cells enlarge and simulate the appearance of the egg apparatus so much so that unless one knows whether he is observing the micropylar or the chalazal end, the three antipodal cells may be mistaken for the egg apparatus.

In post fertilization stages the antipodal cells greatly enlarge and their nuclei become amoeboid and lobed. Later the muslin break up and the fragments become distributed in the cytoplasm. Finally the cell walls lose their sharpness and the amalgamated protoplast of the three cells shows irregularly scattered fragments of chromatin. Before the embryo has well advanced and the differentiation of the cotyledons has been initiated from the globular embryonal mass of cells, the antipodal protoplast becomes absorbed.

The endosperm is free nuclear. Wall formation starts from the periphery inwards when the embryo is still quite young.

The young proembryo has a very prominent and massive suspensor nearly four times longer and twice as broad as the embryo proper. It appears like a bunch of grapes whose cells are gorged with starch grains and have large nuclei.

20. Studies in Umbelliferae. I. *Foeniculum Vulgare,* Mill.

J. S. AGRAWAL, Delhi.

Germination of the seed is epigeal. One cremocarp on germination produces two seedlings both of which develop to maturity. The inflorescence is an ebracteate compound umbel with about sixteen umbellates arranged in 3—5 whorls comprising a total of about 250 flowers. After the initiation of the bud the flower takes 21 days for opening. The calyx is rudimentary, the petals remain incurved, the stamens straighten out one by one and it takes approximately 43 hours for the process of opening of the flowers and shedding of the petals and stamens. The flowers are protandrous and mostly insect pollinated. The frequency of insects visiting the umbels is at a maximum between 9. 30 A. M. and 11. 30 A. M.

The young anther shows three wall layers of which only the fibrous endothecium persists at maturity. Normally there are four pollen sacs in each anther which sometimes show a tendency to enlarge and constrict so that each sac appears two-lobed but it never completely divides. The archesporial tissue is a hypodermal plate of cells in each lobe. The tapetum is glandular and multinucleate, and persists until the formation of the pollen grains. The quadripartition of the microspore mother cell takes place by furrowing. Isobilateral and tetrahedral tetrads are formed. The pollen grains are ellipsoidal and three celled at the time of shedding. Each shows two elongated sperm cells one lying at each pole.

The ovules are anatropous, unitegmic and tenuinucellate. The archesporium consists of one to several cells. No parietal cell is cut off. The embryo sac is eight-nucleate.

21. Life of *Coriandrum Sativum* L.

RIPUSUDAN LAL PALIWAL, Agra.

The inflorescene is a compound umbel. Each umbellate comprises five to six whorls of flowers. Those of the outermost whorl, which are zygomorphic, and the central flower which is actinomorphic, alone are fertile, while all the flowers of the intermediate whorls, which show a decreasing amount of zygomorphy from outside inwards, are sterile.

Development of the male gametophyte proceeds normally in all flowers. The young microspore is pear-shaped, which soon becomes ellipsoidal. In earlier stages its nucleus lies at one end. Subsequently it travels to the equatorial region where it divides to form a vegetative and a generative cell. The generative cell divides either in the equatorial region migrates to one of the two poles where it divides either the two male cells one of which migrates to the opposite pole. At the time of shedding, the pollen grains are three-celled with a tube nucleus in the equatorial region and two elongated sperm cells lying one at each pole.

Three to ten archesporial cells originate in the nucellus. Of these only one or two function as megaspore mother cells. Both linear as well as T-shaped tetrads of megaspores are formed. The chalazal megaspore generally functions to form a normal eight-nucleate embryo sac. A mass of dark-staining cells (hypostase) is present in the lower part of the ovule.

There is well marked gradation in the extent to which the sterile flowers develop. The innermost whorl of sterile flowers degenerate at the megaspore mother cell stage. Those of the next outer whorl may show early stages of division of megaspore mother cell, and those of the outermost whorl of sterile flowers go up to the megaspore tetrad stage.

22. Development of the Female Gametophyte and Endosperm in *Glossostigma Spathulatum*.

K. M. SAFEEULLA, Bangalore.

The archesporial cell functions directly as the megaspore mother cell, and the development of the embryo sac conforms to the *Polygonum* type. Double fertilisation occurs.

The first division of the primary endosperm nucleus is followed by the laying down of a transverse wall. The chalazal chamber does not show further nuclear divisions and directly functions as the chalazal haustorium. The first division in the micropylar chamber is vertical and the second is transverse, resulting in two tiers of two cells each. Of these the upper develops into the two-celled micropylar haustorium, and the two cells of the lower undergo further divisions to give rise to the endosperm proper.

The micropylar and chalazal haustoria are of the non-aggressive type. In the mature state, the micropylar haustorium is constituted by two uninucleate cells, while the chalazal haustorium remains one-celled and uninucleate. The formation of the embryo is belated and it develops after the differentiation of the endosperm.

Phanero gams

23. Studies in the Embryology of some Members of the Bignoniaceae,

H. C. GOVINDU, Bangalore.

An account of megasporogenesis and endosperm formation in *Jacaranda mimosaefolia* D. Don., *Parmentiera cerifera* Seem. and *Tecoma stans* (L.) H. B. K. is presented. Development of the female gametophyte of *Kigelia pinnata* DC. is also included. The development of the floral parts has been studied in case of *T. stans*.

The floral parts of *T. stans* arise in acropetal succession, the anterior members of each whorl always preceeding the posterior ones in development.

The ovary is superior, bicarpellary and bilocular. The numerous ovules are usually anatropous or raeely amphitropous and are borne on the axile placenta. The ovules have a single massive integument. Its innermost layer forms the integumentary tapetum which surrounds the non-dilated chalazal portion of the embryo sac. A nutritive tissue of radiating cells is present, at the chalaza. The embryo-sac is of the '*Polygonum*-type' The synergids are hooked and show pointed apices. The antipodals are organised as definite cells.

The endosperm is cellular and conforms with minor variations to the *Catalpa*-type of Mauritzon. The chalazal haustorium is aggressive and four-celled in *J. mimosaefolia* and *T. stans,* and two-celled in *P. cerifera.* In contrast, the micropylar haustorium is weakly developed. It is four-celled in *J. mimosaefolia* and two-celled in the other two forms. In *P. cerifera,* however, the two topmost cells of the endosperm become tubiform in late stages.

24. The Embryology of *Cistanche Tubulosa* Wight.

B. TIAGI, Ajmer.

Cistanche tubulosa is a large parasite occurring on the roots of *Calotropis* and *Acacia.* It is found on sandy dunes in the months of January and February only. The stamens become pseudo-syngenesious by the interlocking of the hairs formed by the proliferation of the epidermal cells of the anthers. The ovary is unilocular with four massive, parietal T-shaped placentae. The floral parts develop in acropetal order. The anther is a four-lobed structure with one crescent-shaped pollen sac in each lobe. The archesporial tissue consists of a group of hypodermal cells. The tapetal cells are radially elongated, binucleate and of the glandular type. They degenerate by the time microspores have been formed. Sometimes two or more layers of tapetum can be distinguished in a lobe. The quadripartition of the microspore mother cells takes place by furrowing resulting in tetrahedral, iso-bilateral and decussate type of tetrads. At the time of sheeding the pollen grains is two-celled, three-furrowed and with a smooth exine.

The ovules are tenui-nucellate, unitegmic and anatropous. The innermost layer of the integument forms a nutritive jacket around the developing embryo sac as the single-layered nucellus degenerates. Ultimately in the seed the nutritive jacket becomes cutinised and surrounds the endosperm. There is one hypodermal archesporial cell in each ovule. It functions directly without cutting a partietal cell. The embryo sac is of the *Polygonum* type. The antipodal cells are persistent but the synergids disappear soon after fertilisation. The polar nuclei fuse to form a large secondary nucleus. Fertilisation is porogamous and the endosperm is cellular.

The first wall in endosperm formation is transverse resulting in a micropylar and a chalazal chamber. The nucleus of the chalazal chamber divides but once and forms a weak one-celled, two-nucleate chalazal haustorium. The micropylar chamber divides by a longitudinal wall. The next division in this chamber is transverse delimiting the two micropylar haustorial cells from the middle tier, which by further transverse and longitudinal divisions gives rise to the endosperm proper. The micropylar haustorium is very aggressive and draws food materials by hypha-like branched processes penetrating the integument. The endosperm contains starch and oil. The proembryo has a long four-to five-celled suspensor which disintegrates and the mature embryo an undifferentiated mass embedded in the endosperm. The minute seeds are produced in abundance. The cells of the testa are large and reticulately thickened. Majority of the seeds are sterile.

25. Life History of *Cucumis Melo* L. Var. *Pubescens.* Willd.

RIPUSUDAN LAL PALIWAL, Agra.

The pollen grains of *Cucumis melo* L. var. *pubescens,* germinated in sugar-agar concentrations of 2.5%, show frequent branching of pollen tubes. The individual branches grow for an appreciable length. Some pollen grains also showed a slight tendency towards the polysiphonic condition.

The embryo sac develops according to the *Polygonum* type. Functioning megaspores with only two degenerating cells situated above were also observed. In such cases the upper cell is the undivided dyad cell.

The ovule has two integuments of which the inner is crushed and destroyed at the apex by the growth of nucellar beak. The pollen tube enters the embryo sac by destroying the cells of this nucellar beak.

26. Embryo Sac and Endosperm in *Lavenhookia Dubia* Sond in *Lehm.*

K. SUBRAMANYAM, Bangalore.

Lavenhookia dubia is a member of the family Stylidiaceae, material of which was obtained from Melbourne, Australia.

The ovary is inferior, unilocular, with a large number of anatropous ovules borne on a basal globose placenta. The ovules at the base of the placenta are amphitropous. Multicellular glands borne on biseriate stalks are present on the outer wall of the inferior ovary.

Megasporogensis proceeds normally and the development of the embryo sac follows the *Polygonum* type. Occasionally a T-shaped tetrad is met with and the upper dyad cell shows a belated division. The mature embryo sac is long and tapering at both ends. Its lower portion is surrounded by an endothelium. The synergids are elongated, exhibit characteristic hooks and rarely a filiform apparatus. The egg is pear-shaped. The antipodals are organised as definite cells, with their ends pointed below. A case was met with, which in the pointed ends of the antipodals had penetrated in between the cells of the chalazal tissue, thus behaving as weak antipodal haustoria. The embryo sac develops a small process at the chalazal end. Double fertilisation has been observed.

The endosperm is cellular and it follows the *Scutelaria* type of Schnarf. The micropylar haustorium is made up of two uninucleate cells which develop short processes penetrating between the cells of the integument. The chalazal haustorium is also two-called and gives rise to long tubular prolongations which grow up in between the cells of the integument.

27. The Embryo Sac of *Fritillaria Liliacea.*

J. S. AGRAWAL, Delhi.

The trilocular ovary has numerous anatropous bitegmic ovules arranged in two longitudinal rows on an axile placenta in each loculus. The hypodermal archesporial cell functions directly as the megaspore mother cell without cutting off any wall cell. It undergoes the usual reduction divisions and produces four free megaspore nuclei lying cross-wise or in a linear row in the same cell. The two central (or lateral if arranged cross-wise) nuclei move towards the chalazal end resulting in a 1 + 3 stage. The two groups of nuclei divide simultaneously. The micropylar nucleus produces two haploid daughter nuclei whereas in the chalazal region the three spindles fuse and result in two triploid nuclei. The two micropylar nuclei undergo another division; out of the four daughter nuclei thus produced, three organise into an egg apparatus and the fourth is the upper polar nucleus. Out of the two triploid chalazal nuclei the basal usually degenerates while the upper elongates and divides once to produce the lower polar nucleus and a single antipodal cell. The lower polar nucleus enlarges while the antipodal cell soon degenerates. Thus the mature embryo sac develops according to the *Fritillaria* type and is seven-nucleate.

Frequently the basal nucleus of the secondary four nucleate stage fragments to form three or, four nuclei. In such cases as many as 6—7 antipodal cells may be seen.

28. Occurrence of Peristent Pollen Tubes in the Ovles of some Angiosperms.

P. MAHESHWARI and B. M. JOHRI, Delhi.

Pollen tubes frequently persist in the micropylar part of the ovules of *Hydrilla, Ottelia* and *Boerhaavia* for a long time after fertilization. Some workers who have also observed similar pollen tubes in other plants conclude that these are haustorial structures which transmit food material to the growing embryo. Our observations indicate that soon after fertilization the pollen tube appears as a densely staining organ without a nucleus or active cytoplasm which are the usual signs of a haustorium., It appears, therefore, that such pollen tubes are merely dead strutures which persist for a long time but are quite functionless.

29. Seasonal and Regional Variations in Shape, Size and Structure of Pollen Grains—I.

T. C. N. SINGH and A. T. NATARAJAN, Annamalainagar.

Investigations during the past one year on the pollen grains of eighteen species spreading over twelve families (*e.g.* Nyctaginaceae, Capparidaceae, Caesalpineae, Papilionatae, Euphorbiaceae, Vitaceae, Tiliaceae, Combretaceae, Apocynaceae, Scrophulariaceae, Rubiaceae and Compositae) have shown that pollen grains exhibit variations in shape, size and structure both in time and space:

I. Seasonal variations in size and shape of pollen grains, (from Annamalainagar) have been found in *Bougainvillaea spectablis* Will., *Gynandropsis pentaphylla* DC., *Caesalpinia pulcherrima* Swartz., *Abrus precatorius* Linn., *Clitoria ternatea* Linn., *Allamanda cathartica* Linn. and *Hamelia patens.* *Jacq*-Enum.

II. Seasonal variation in structure of pollen grains in addition to their shape and size (from Annamalainagar) has been found in *Abrus precatorius* Linn.

III. Regional variations in size and shape of the pollen grains (from Annamalainagar, Tambaram and Nagpur) has been found in *Gynandropsis pentaphylla* DC., *Caesalpinia pulcherrima* Swartz., *Abrus precatorius* Linn, *Jatropha glandulifera* Roxb., *Quisqualis indica* Linn., *Allamanda chathartica* Linn., *Vinca rosea* Linn., *Angelonia grandiflora* Hort., *Hamelia patens* Jacq-Enum, *Olden-landia umbellata* Linn. and *Tridax procumbens* Linn.

IV. Regional variation in shape of pollen grains (from Annamalainagar and Banaras) has been found in *Morinda tinctoria* Roxb.

V. Regional variation in structure of pollen grains in addition to their shape and size (from Thirumyiladi and Vellore) has been found in *Cissus quadrangularis* Linn.

The significance of these variations is discussed.

30. Anatomy of the Haustorium of *Dendrophthoe Falcata* (Linn. fil) Ettingshausen.

BAHADUR SINGH, Agra.

The haustorium develops from the radicle end of the seedling which pierces into the stem of the host. Curiously enough the vascular bundles are collateral, open, endarch and arranged in the form of a compressed ring as in phylloclade, the plane of compression being parallel to the longitudinal axis of the host.

A number of massive sheathes arising in acropetal succession receive the vascular supply from the marginal bundles of the compressed ring. These sheathes, which like the rest of the tissue of the haustorium, are formed for the most part of parenchymatous cells, spread into the tissue of the host forming the woody swelling, known as the "burr".

31. The Origin, Development and Morphology of the Intrapetiolar Stipules of *Tabernaemontana Coronaria* Br.

G. C. MITRA, Calcutta.

By transverse extensions at two particular sectors of the free apex the opposite primordia are initiated at the same time and their production appears to exhaust the former for further laying down of primordia with the result that it becomes a cup-shaped structure. At the end of a fairly long plastochrone the apex becomes convex again when another pair of primordia is laid down. The shape of the free apex, concave or convex, is thus indicative of the beginning or the end of a plastochrone when primordia are being laid down in the vegetative bud.

At the earliest stage the primordium consists only of a base (axial component); with the lateral extensions of the latter the free limb is erected which is unsegmented and undifferentiated. Meanwhil the axial components of the opposite primordia extend tangentially around the free apex until their lateral ends meet and fuse to form a tubular sheath around the apex with which it grows united for some time. In a transverse section of the terminal bud the axis is seen to consist of a peripheral mantle composed of the leaf-bases (axial components) and an axial core of vacuolating dividing cells completely enclosed by the former.

After being free from the axis the sheath continues a free tubular upward growth for some distance when it separates into the two free bases.

The stipule is formed by the separation of the arms along with the adaxial portion of the central region of the free base as a single piece. It contains 4 branches—all derived from the laterals. Homgeneity of the tissues of the stipule does not support the contention of Goebel that a new formation connects the pair of free lateral stipules to form the axillary stipule in this case. The upgrowth of the adaxial portion of the central region of the base along with the lateral portions in the formation of the stipule is continuous, and as a result the middle portion of the stipule cannot be distinguished from its wings. The branches close by influence this upgrowth.

Three bundles enter each primordium as a single trace, and leave a single gap in the nodal ring. The laterals, however, separate from the median in the axial component and give out 8 slender branches during their upward differentiation. These branches unite in pairs and form bundles which arrange themselves along the inner face of the central region of each free base. These 4 bundles form the stipular trace.

The origin of the stipule in this case differs from the other types in the fact that not only the arms but also the adaxial portion of the central region of the free base takes part. Their formations are influenced, as in all the other types of stipules, by the branches of the laterals.

32. Notes on the Anatomy of Peduncles in Palms.

T. S. MAHABALE and N. N. UDWADIA, Bombay.

Peduncles are generally recognised the more conservative part as among flowering plants. To the best of our knowledge, the anatomy of peduncle in palms has not been worked out, although a good deal of work has been done on the anatomy of the stem. The peduncles of some twenty species of palms belonging to different genera were studied anatomically and it was found that they present some significant characters for understanding the structure and taxonomy of fossil and living palms. The shape of the fibrovascular bundles, particularly in peduncles, is not such a reliable guide to taxonomy as some other characters, as it varies from the base to the apex of the peduncle. The more reliable characters for this purpose are to be found in the structure and distribution of the ground tissue as pointed out by Sahni, Kaul and others.

33. Floral Anatomy of Some Malvales and Geraniales and its Bearing on the Affinities of the two Orders.

C. VENKATA RAO, Waltair.

In Sterculiaceae the writer found that contrary to the description commonly given, the androecium consists of outer antipetalous fertile and inner antisepalous sterile whorls. To correlate the findings with other families, the floral anatomy of the following plants was studied and the results embodied in the paper: (*a*) Malvaceae—*Malvaviscus arboreus, Hibiscus rosa-sinensis, Bombax malabaricum;* (*b*) Tiliaceae: *Triumfetta rhomboidea, Corchorus acutangulus;* (*c*) Geraniaceae: *Oxalis corniculata.*

In all the Malvales studied, the fertile whorl of stamens is found to be antipetalous with traces in common with those of petals, just as in *Oxalis* where typical obdiplostemony is seen. In some Sterculiaceae an inner sterile whorl is seen which is suppressed in Malvaceae and Tiliaceae. The numerous stamens in these families are the result of branching of the outer whorl. Restriction of the number of stamens of each whorl to five would naturally result in typical obdiplostemony. This fundamental uniformity in the anatomical structure of the flowers brings the Malvales and Geraniales closer to each other. Sterculiaceae is found to contain some primitive pentacyclic flowers and a suggestion is made for the derivation of the other floral types in Malvales from them.

34. Studies in the Morphology of a new Species of *Abrus.*

C. SRINIVASAN, Annamalainagar.

Abrus precatorius, Linn., has till now been recognised and represented in the Indian flora as having red and white seeds. Taxonomic and morphological studies of the seed-coat, leaves, epidermal characters, inflorescences, flower colour, time of flowering, and anatomical studies of the stem, root, petiole, pulvinus, leaflets have all been found to be so different in the plants raised from red and white seeds that the white seeded *Abrus* should be given the status of a separate species. The name *Abrus natarajansis* sp. nov. is proposed for this after Lord Nataraja of Chidambaram.

35. A Contribution Towards the Study of the Dispersal Mechanism in Flowering Plants of Mysore (South India).

BASHEER AHMED RAZI, Bangalore.

In a recent paper the author (Razi 1946) gave a check list of the flowering plants of Mysore embodying the field survey carried out for several years. An attempt was made to indicate the life forms on the basis of Raunkiaer's system. Studies on the dispersal mechanisms of the flowering plants of Mysore were also taken up with a view to get a better understanding of the plant distribution. Two main groups of dispersal mechanisms are recognised; the "ACTIVE" and the "PASSIVE", depending on whether the plant is directly concerned in modifying its fruit structure to suit the mode of dispersal, or whether an extraneous agency partakes in this process. Plants having the active mode include those with explosive fruits and others showing a mechanical contrivance for dispersal. The second category includes plants dispersed through the agency of wind, water, animals etc.

36. Pharmacognostical Studies of the Leaves and Stems of *Andrographis Paniculata* Nees.

G. C. MITRA and S. N. BAL, Calcutta..

'Kalmegh' of the Indian Pharmacopoeial list contains the dried or fresh leaves and stems of the plant *Andrographis paniculata* Nees. It is used as a substitute for Quassia and 'Chiretta' and the latter is very often adulterated with 'Kalmegh'.

Pharmacognostical characters of the leaves and the stems of *Andrographis paniculata* have been investigated to find out the distinguishing features. Cystoliths are present in the epidermals cells only of the leaves and stems. They occur singly but rarely in pairs. They are either round or elongated in shape with blunt ends. Stomata are present only on the lower epidermis and are associated with two subsidiary cells which are placed transversely to the stoma. The stem is quadrangular. Collechymatous cells are present at the corners and are patches below the epidermis. Interxylary and intraxylary phloem are absent. The xylem consists mostly of wood prosenchyma with scattered vessels.

The values for palisade ratio (4), stomatal index (26), vein-islet number (4), number of epidermal cells per sq. mm. (283) and of stomata per sq. mm. of (78) have been determined.

The leaves and the stems contain 6.08% and 1.07% respectively of crude andrographolide. The proportion of stems in the crude drug should not exceed 10%.

37. The Leaf-base and the Internode: their True Morphology.

G. P. MAJUMDAR and G. C. MITRA, Calcutta.

In our text-books and manuals of Botany by *leaf primordium* is meant the usegmented papillate outgrowth at the side of the apical dome ('primordialblatt' of Eichler) which can be distinguished into two parts, namely, an upper (oberblatt) and a lower ('unterblatt' or 'blattgrund') not on any visible symptoms but on the share they take in later development. According to this idea the *leaf-base* is the region of the leaf by means of which it is attached to the axis (region of insertion) unless the base is specially formed, such as, the pulvinus, leaf-sheath, etc.

Our developmental studies of 14 species of plant (dicotyledons) show that in the origin of a leaf primordium the first part to be laid down at the shoot apex is the *axial component* (*soubassement foliares,* Gregoire) of the primordium which in all cases is incorporated in the axis, and on this the primordium, *i.e.* the free limb, is erected under the influence of the acropetally differentiating median and the lateral trace bundles in the desmogen stage. This axial component is a part of the leaf, and *is really its base.* The result of our studies lead us to conclude: (1) the axial component is an integral part of the leaf and it forms its base; (2) when the whole of it remains incorporated in the axis for a comparatively short length (leaf cushion) and free for a considerable length, the free portion of the base is sheathing, as in *Bacopa monieria, Polygonum orientale,* etc.

The above observations lead us further to the question of the nature of the *internode.* In serial transections of the terminal buds in all the species studied the axis in bud is seen to consist of a peripheral *mantle* composed of the axial component or components (leafbases) enclosing an *axial core.* The axial core and the mantle are derived from two different zones of apical meristem, namely, the file meristem and the flank meristem respectively. The axial core corresponds to the pith, and the mantle includes the entire region outside it. Thus the Berindung Theory of Hofmeister (1851) is revived with some modifications of the Leaf-skin Theory of Saunders (1922).

38. Investigations on Indian Jasmines of Commercial Value.

Amiya Datta, Calcutta.

The paper deals with systematic account of 12 species of Jasmines of commercial value, which may be used in the enfleurage of pure jasminum oil in India. All the species taken into account have either strong or feeble smell. It is asserted that the best yielder of the essential oil may be had from *Jasminum grandiflorum* Linn. (Chameli). *Jasminum sambac* Ait. and *J. auriculatum* comes as second and third as regards the quality of perfume they yield. The result is correlated with the actual findings by enfleurage experiments carried out in the laboratory of the Tata Oil Mills Co. Ltd. A key has been drawn for the classification of those 12 species. The commercial value and the market rate of Jasminum flowers and the possibility of use of these flowers in the Essential oil industry of the country has also been discussed.

39. Studies on Comparative Anatomy of Indian Acanthaceae (Epidermal Cells and Stoma).

Amiya Datta, Calcutta.

The epidermal cells are mostly thin walled with outer thick covering, excepting in *Acanthus illicifolius* and a few others, where they are thick walled. Preponderance of tangential and vertical divisions of epidermal cells are met with in *Eranthemum* and few others. Some of the cells of the epidermis are a bit bigger and lodges within them crystals of calcium carbonate (cystolith). These may be called cystalith-sacs. These are absent in *Thunbergia, Nelsonia, Acanthus, Asystasia* and *Aphelandra* where no cystoliths are found.

Stoma are present is young stems of all the plants examined and specially in angular or furrowed stems, e.g., *Andrographis, Phlogacanthus, Dicliptera* etc., where the stoma are arranged in vertical rows throughout the length of the stem in furrowed position.

40. Studies on Comparative Anatomy of Indian Acanthaceae, (Epidermal Hairs).

Amiya Datta, Calcutta.

The general structure of epidemal hairs are thickwalled, uniseriate and pitted, of varying number of cells and of different shapes. The speciality is found in *Aphelandra* in which it consists of one linear long thick walled tip cell with two basal small cells;

in *Thunbergia* the hair is unicellular, thickwalled, short hook-like; in *Nelsonia* they are thin, membranous, many celled with the tip cell thickened; in *Jacobiana* the hairs are multicellular, uniseriate, small cells with thick walls.

41. Studies on Comparative Anatomy of Indian Acanthaceae (Glands).

AMIYA DATTA, Calcutta.

The glandular structures in all the 32 species studied can be classified into two general types of non-stalked external glands of different sizes. The first type which is found in *Thunbergia* and *Nelsonia* are panduriform and bicellular glands with one vertical wall or disc shaped and the second type which is found in the rest of the species are unicellular or multicellular with more than one vertical wall.

42. Identification of a Few Important Indian Leaf Drugs.

S. C. DATTA AND R. L. DESAI, Calcutta.

Crude drugs, as sold in the Indian market in broken or powdered state are often found adulterated or some other drug is substituted for the genuine one. Common botanical methods of identification by morphological characters are of no value in this case. Nine leaf drugs viz., *Datura metal.* L., *D. fastuosa.*, L., *D. stramonium*, L., *Solanum nigrum*, L., *Solanum xanthocarpum*, Sch. & W., *Adhatoda vasica, Nees.*, *Andrographis paniculata, Nees.*, *Trianthema monogyna*, L., and *Boerhavia diffusa*, L., have been studied. It has been found that vein islet numbers, vein islet appearence and appearence of the veins on the upper and lower surfaces of the leaves are important factors in the identification of leaves from dry powdered or crushed samples. The vein islet numbers in *Datura* species vary from 13.2 to 20.9, in *Solanum* species from 21.9 to 26.3, in *Adhatoda*, 7.1, in *Andrographis* 12.2, in *Boerhaqvia* 4.8 and in *Trianthema* 6.8.

43. Pharmacognostic Studies on Roots and Rhizome Drugs of India.

S. C. DATTA, Calcutta.

According to the Ayurvedic system of medicine, a number of drugs obtained from the roots ,of many Indian plants, are reputed to be efficacious. The identification of these crude drugs from commercial samples is very difficult as they are sold in dry state in powdered or broken condition. Botanical identification by morphological characters can not be applicable to these as they are incomplete specimens and possess no reporductive organs which are considered the main factor in the classification. Pharmacognostic characters of 56 root and rhizome drugs, distributed over a large number of families of Dicotyledons and Monocotyledons have been studied. For each particular drug, a number of data, viz. synonyms, vernacular names, source, habitat, standard, macroscopic and microscopic characters of roots and rhizomes and their powders, chemical constituents along with action and uses, have been dealt with. A map regarding distribution of these drugs in India have been worked out. After a careful consideration of the anatomical structures of roots, and rhizomes and their microchemical tests, the author has brought out a schedule for identification of these drugs and their features. The work is considered to be of value to drug dealers, manufacturers, drug inspectors, and students, for ascertaining the identity and purity of the drugs.

44. Pharmacognostic Studies on *Vitex Trifolia* Linn. An Insect-Repellant Plant.

S. C. DATTA, Calcutta.

The plant *Vitex trifolia* Linn. has been found by the author to possess strong insect-repellant properties. The plant is non-poisonous and is therefore of special value in the preservation of food grains, like cereals, rice etc. About 10 gms. of dry powdered leaves per pound of food grains, i.e., about 1 seer of dry leaves per maund of food grains was found sufficient for preservation of food grains from the attack of insects Experiments on preservation of food grains was done with rice and gram and it was also found that it is well applicable to other food grains like wheat, jowar etc. The macroscopical and anatomical characters along with microchemical tests and results of qualitative chemical assay has been presented in this paper. The insect-repellant properties are attributed to the presence of a highly aromatic essential oil in the leaves. Chemical assay showed the presence of tannins, reducing sugars, glucosides, plant mucins and saponins, along with resinous matter and aromatic essential oil which are the chief constitutents.

Mycology and Plant Pathology

45. Studies in the Occurrence of Bacteria in the stem and Leaves of Plant—I.

T. C. N. SINGH AND V. R. RAJAGOPALAM, Annamalainagar.

A study during the last one year has demonstrated the occurrence of bacteria in the following thirty-one species of plants of the local flora:

(1) *Typha angustata* Bory. and Chaub., (2) *Cyperus rotundus* Linn., (3) *Scirpus articulatus* Linn., (4) *Monochoria hastaefolia* Paresl., (5) *Ficus religiosa* Linn., (6) *Salicornia brachiata* Roxb., (7) *Sesuvium portulacastrum* Linn., (8) *Nymphaea pubescens* Willd., (9) *Polyalthia longifolia* Hook., (10) *Cleome viscosa* Linn., (11) *Gynandropsis pentaphylla* DC., (12) *Neptunia oleracea* Lour., (13) *Glycosmis cochinchinensis* Pierre., (14) *Mangifera indica* Linn., (15) *Sonneratia apetala* Buch.-Ham., (16) *Rhizophora mucronata* Lamk. (17) *Bruguiera caryophylloides* Blume, (18) *Lumnitzera racemosa* Willd., (19) *Memecylon umbellatum* Burn., (20) *Aegiceras majus* Gaertn., (21) *Bassia latifolia* Linn., (22) *Allamanda cathartica* Linn., (23) *Ipomoea aquatica* Forsk., (24) *Lippia nodiflora* Michux., (25) *Clerodendron inerme* Gaertn., (26) *Avicennia officinalis* Linn., (27) *Martynia annua* Linn., (28) *Acanthus ilicifolius* Linn., (29) *Ixora coccinea* Linn., (30) *Pavetta indica* Linn. and (31) *Marsilia* sp.

A full description of each species is recorded with illustrations; and the significance of the occurrence of bacteria is discussed and explained.

46. A Case of Apparent Symbiosis of *Lagerstroemia Flos Reginae* Retz, with *Marasmius Campanella* Holt.

S. R. BOSE AND MISS. PARUL CHATTERJEE, Calcutta.

Lagerstroemia flosreginae is a common roadside tree in Calcutta and other towns. Every year during the rains a large number of tiny fructifications of *Marasmius campanella* comes out on the bark of the main trunk and of the older branches of adult trees, the younger branches of adult trees as well as very young plants being free from it. The health of these trees is not affected. The observation has been extended for 10-12 years on large number of trees from different parts of Bengal and this year the same fructification has been collected from some trees of the Bombay City. Sections of the stem, root, shoot apices, flower stalks, seed-coat etc. of such adult and young plants revealed abundant hypha in all healthy trees throughout the year, in fact in every part of the plant. On dipping a branch in water, crops of tiny fructifications come out after a lapse of 2-3 months.

The fungus has been grown from spores in pure culture in tubes where it has formed small fruit-body of *M. campanella* after a lapse of 2-3 months.

Further work to locate the fungus in funicle and the placenta inside the ovary and in freshly germinated seedlings is proceeding.

47. A note on the Occurrence of Mycorhiza in *Aristolocia Bracteata* Retz.

S. VENUGOPALAN, Annamalainagar.

An anatomical study of *Aristolochia bracteata* was made and it was found than an endophytic mycorhiza inhabits the rhizome, stem and leaves. It was also observed in the wall of young ovaries just prior to the organisation of the axile placenta. The mycelium is found in profusion in the parenchymatous cells of the cortex, pith and medullary rays of rhizome and stem and also in the spongy parenchyma of the leaves. Hyphae are occasionally seen to protrude out of the surface of the rhizome in tufts. This is believed to be the first record of a mycorhiza in *Aristolochia.*

48. Survey of the Antibiotic-Producing *Penicillium* Sp. from the Soils of West Bengal.

P. N. NANDI, Calcutta.

Since the discovery of penicillin, microbiologists have taken up the problem of surveying the occurrence and distribution of antibiotic-producing micro-organisms.

The work reported here was undertaken to survey the penicillin-producing moulds from the soils of West Bengal. Up to the present time 48 samples of soil have been investigated and 250 strains of *Penicillium* isolated from dilution plates. They were grown on Czapek-Dox medium with Corn steep liquor and filtrates were assayed against *Staph. aureus* and *B. coli* as test organisms.14 strains inhibited *Staph. aureus* alone and 4 inhibited both *Staph. aureus* and *B. coli.* The maximum diameter of the zone of inhibition was 22 mm in one case (F. 1. 10). which is equivalent to approximately one unit of penicillin per millilitre of the medium.

49. *Arachniotus* Species within the Rhizomes of *Psilotum Flaccidum.*

M. J. THIRUMALACHAR, Banaras.

An *Arachniotus* species was isolated in culture from surface sterilized underground stems of *Psilotum flaccidum* plants grown in the Botanical Gardens, Central College, Bangalore. The fungus was first located in cross sections of the rhizomes, filling up the lumen of some of the outer cortical cells. In artificial culture, the fungus forms an effuse, white delicate mycelium, developing obovate to spherical, whitish cleistothecia, which are 1 to 2 mm. in length. The asci are numerous, 7 to 10 μ in diameter and 8-spored. Mature ascospores are oblong-ellipsoid, hyaline, mostly, 3.5 x 2.5 μ and thin-walled. The fungus is tentatively identified as *A. terrestris* Raillo, reported to be a soil inhabitant in Russia, though the ascospore measurements differ. Recent studies by Rosenbaum has shown that *Arachniotus* is related to Trichophytoneae of the dermatophytes, occupying a position between the Gymnoascaceae and the Aspergillaceae.

50. Notes on two Fungi Parasitic on Scale Insects.

M. J. THIRUMALACHAR, Banaras.

A fungus parasitic on scale insects collected on leaves of *Gymnosporia ovata* in Khandala was found on examination to be *Uredinella spinulosa* Couch and Petch. The genus *Uredinella* established by Couch is of great interest since it shows characters intermediate between the plant rusts and *Septobasidium.* The hymenium is composed of two types of cells, the teleutospores which are obovate to ellipsoidal, always borne on a pedicel, and somewhat elongated teleutospore-like cells which are however without distinct stalk cells. Some of the germination stages of the two spore forms have been studied.

An entomogenous fungus parasitising aleyrodoid insects on the leaves of *Murraya exotica* and *Trema orientalis* collected in Nandi Hills, Mysore, has been identified as *Aschersonia papillata* Petch. The fungus forms hard flattened stroma up to 2.5 mm in diameter, white along the margin and orange coloured in the centre. The pycnia are large. The pycnospores measure 10-15 x 1-1. 5 μ and often become spuriously one-septate. The fungus has been studied in artificial culture.

51. Effect of Sulpha-drugs on the Growth of *Pestalotia* Spp.

R. N. Tandon and M. P. Tandon, Allahabad.

Pestalotia spp. was isolated from rotten apples and mummified guavas. The isolate from apples is designated as P1 and that from guava as P2.

Asthana and Hawker's medium A without agar was used as control. Sulpha drugs —Sulphadiazine Sulphaguanidine, Sulphamerazine, Sulphanilamide, Sulphapyridine and Sulphathiazole—were added individually to the nutrient medium in concentrations of 0.025%, 0.05%, 0.075% and 0.1 %. The weight of the fungus after three weeks' incubation was used as a quantitative measure for comparing its growth.

Both the forms of *Pestalotia* spp. gave different results with different Sulpha drugs. Sulphanilamide and Sulphathiazole appeared to be most injurious, since on these the growth of the fungi was extremely poor. Sulphapyridine also supported only feeble growth, but fair amount of growth was observed on Sulphamerazine and Sulphaguanidine. On Sulphadiazine, however, excellant growth of P2 was observed being even better than on the control, though with P1 its injurious effects were quite pronounced.

Subsequent inoculation of the fungi on Oat meal agar or on medium A after their removal from the Sulpha drugs gave normal growth. Thus it was evident that wherever *Pestalotia* spp. showed a poor development it was only due to the Sulpha drug exerting a fungi static (not fungicidal) action which became more pronounced with increased concentrations.

Microscopic examinations revealed that some of the Sulpha drugs are capital of causing morphological abnormality in mycelium and spores of both P1 and P2. Production of long chains of chlamydospores of different colours was a common feature wherever poor growth was observed.

52. On the Leaf Spot Disease of *Citrus Acida* Var. *Variegata.*

J. N. Rai.

A blight disease of the leaves of *Citrus acida* var. *variegata* is conspicuous during the rainy season. The causal organism has been found to be a new strain of *Colletotrichum gloeosporides* penz., which attacks only the leaves of this particular variety of citrus. An effort to infect the leaves of other varieties and species of citrus has failed.

The results of the inoculation experiments under varied conditions, and the morphological description of the fungus are embodied in the paper.

53. The Enzymic Studies of *Alternaria Tenuis* Auct. Sensu Whiltshire, *Curvularia Lunata* (Wakker) Boed and *Fusarium Coeruleum* (Lib.) Sacc.

R. N. Tandon and J. P. Srivastava, Allahabad.

Investigation was undertaken to study some of the important extracellular and intracellular enzymes of *Alternaria tenuis, Curvularia lunata,* and *Fusarium coeruleum.* Both qualitative and quantitative tests were employed. The former included *in vivo* as well as *in vitro* methods.

A. tenuis responded positively for the following enzymes:

Lipase, butyrase, amylase, invertase, raffinase, maltase, emulsin, cellulase, hemicellulase, pectinase, proteolytic enzymes, erepsin and urease. However buty-rase was not secreted as extracellular enzyme. Out of all these, cellulase was produced in largest quantity.

C. lunata did not produce butyrase and proteolytic enzymes extracellularly and cellulase intracellularly. *F. coeruleum* did not liberate butyrase as extracellular enzyme and amylase, invertase and emulsin as intracellular enzymes. Enzymes, other than these enumerated to be present in *A. tenuis,* were also produced by these two organisms both intracellularly as well as extracellularly.

Rennatase, laccase, oxidase, peroxidase and Schardinger's enzyme were not produced by any of these three fungi.

54. Partial Vitamin Deficiencies in Four Strains of *Collelotrichum Lindemuthianum.*

R. S. MATHUR, New Delhi.

The effects of thiamin, biotin, inositol and pyridoxine, were studied singly and in combination on the growth of four isolates of *C. Lindemthianum.*

All isolates tested were partially deficient in one or more vitamins. The *alpha* isolate was partially deficient in thiamin, the *beta* isolate had a very weak partial deficiency in biotin, *the gamma* isolate in inositol and biotin, and the *Preston county* isolate partially deficient pyridoxine, inositol and biotin. Thiamin alone was depressing for the *Beta, gamma* and *Preston County* isolates.

55. Nitrogen Requirements of *Alternaria Tenuis* Auct. Sensu Wiltshire and *Curvularia Lunata* (Wakker) Boed.

J. P. SRIVASTAVA, Allahabad.

Nitrogen requirements of *A. tenuis* isolated from wheat grains and *C. lunata* from guavas were studied. Asthana and Hawker's medium was used as the base. Potassium nitrate of that was substituted by a number of organic and inorganic nitrogenous compounds. In each case, the equivalent quantity of nitrogen was taken. It was observed that the two organisms behaved differently.

Greatest dry weight of *A. tenuis* was obtained with hydroxylamine. Potassium nitrite, cystine and cysteine hydrochloride did not support the growth at all. Ammonium compounds, urea, histidine, tryptophane and peptone had retarding effects.

Best growth of *C. lunata* was obtained on the basal medium (i.e. on the medium containing potassium nitrate); d-glutamic acid and asparagin gave more or less similar results. There was no growth on potassium nitrite. Poor growth was obtained on 1-aspartic acid, tryptophane and urea. The retardation was not pronounced with ammonium nitrate.

Plant Physiology

56. Fractional Analysis of Brick-Kiln Fumes and their Effect on the Mango Fruits.

G. S. VERMA, S. C. AGARWALA, J. N. RAI, AND S. N. IYER, Lucknow.

Brick-kiln fumes were passed into different organic solvents and the solvents distilled off. The 'residue' and its various fractions were separately injected into young healthy mangoes.

It has been found that the ether soluble and chloroform soluble constituents are able to induce the appearance of Black-tip disease in the mangoes. If fumes were passed in the healthy mango extract and the fluid was then injected in fruits, this also produced Necrosis at the tip region.

The details of analyses and effect of injecting different constituents in different variety of mangoes are described in the paper. It is believed that the results have an important bearing on understanding of the causation of mango Necrosis.

57. Effect of 2-4 Dichlorophenoxyacetic acid on Germination in *Sorghum Vulgare.*

V. K. Deshmukh and U. K. Kanitkar, Poona.

With the broader object of investigating the effect of plant growth promoting substances on Indian crops preliminary experiments were performed with 2.4 Dichlorophenoxy acetic acid on *Sorghum vulgare.* The seeds were treated with the substance in watery solutions at various concentrations viz., 2 ppm, 100 ppm. and 600 ppm. The time of treatment was varied from 5 minutes to 24 hours. The seeds after treatment were thoroughly washed with water and were then germinated on moist filter paper and in soil.

In Jowar No. 8, the strain used in the investigation, treatments with 100 ppm. for 5 minutes and 10 ppm. for 2 hours accelerated the growth of seedlings in soil as estimated at the end of 15 days. On moist filter paper 2 ppm, 10 ppm and 100 ppm for two hours showed a similar effect in ten days. In all cases treatment with 600 ppm. for any length of time was seen to retard the growth of the seedlings. It could also be seen that the treated seeds show a lesser activity in initial stages of germination than the untreated in both cultures. They however, grew faster than the controls equalising with them within 7 to 10 days and surpassing them in 10 days in filter water culture and in 15 days in soil. It is considered that the treatment increases the rate of growth of the seedlings probably affecting their internal metabolism.

58. Photoperiodic Induction and the Development of Growing Apex in Rice.

S. M. Sircar, New Delhi, and S. P. Sen, Calcutta.

In order to explain the photoperiodic response in rice noted by the senior author an investigation has been made of the changes occurring at the growing apex.

The vegetative apex of rice is very small and only a few mm. in length. A week's short day fails to produce any effect on the growing apex. With two weeks the photoperiodically sensitive ones show early stages of transition from vegetative to reproductive phase; after 3 weeks stages of inflorescence formation are noticed in large number of plants; and in 4 weeks all the apices become converted into axes bearing spikelets.

Prior to floral initiation groups of specialised cells with large nuclei and rich protoplasm are differentiated near about the protoderm. This is associated with a depression at the top of the apex. These groups of cells bulge out and later develop into branches of the inflorescence, bearing more than one spikelet. Stages of transition from vegetative apex to the structure bearing spikelets have been shown.. Generally two tiller-buds are formed during the period of 6 weeks short day exposure and receive the stimulus; consequently the tillers formed from these two buds flower earlier than the remaining tillers. From the results presented in this work it appears that photoperiodic response and growing point development in rice are different from those of other cereals; and it is worth considering further, whether the sequence of reactions involved in the synthesis of flowering hormone as postulated by previous workers in the field fits in with the behaviour of this tropical crop.

59. Manures and Manuring of the Mango, and the Economics of Mango Culture.

P. C. Mallik and B. N. De, Sabour.

Nutritional requirements of the mango have been studied in Pot and field culture. Out of the three main vegetative flush during the year, the shoots of the earliest flush generally produce flower during the next year; the later ones, under normal conditions do not get sufficient time to ripen so as to bear during the next bloom.

Pot culture experiments with mango grafts in quartz sand revealed that N controls the intake of P and K and determines growth, and that P-requirement of mango is much lower than that of K. Mango is very susceptible to K-deficiency while it resists considerably the adverse effect of low P, the deficiency symptoms of which are manifested after a few years. Adverse effects of K and P can be remedied by replenishing the two elements in nutrient solution. Field experiments with fertilizers have confirmed these. Here N had significant effect in increasing growth, which reaches maximum under NPK. Soil and plant material analyses revealed that intake of K is increased in presence of N and vice versa. Also with greater N-take more of P of the soil is utilized but the reverse does not hold good.

Flowering and fruiting also vary with the growth.

N in the form of Am-sulph is most effective in increasing flowering and the best time for its application is June. Slow acting F. Y. M. applied in October has also beneficial effect, as it has given increased flowering over control. P-fertilizers are advantageously used if applied with the slow acting F.Y.M. or Green Manuring. It has been seen that Am. Sulph in June followed by FY.M in October, and both with K manures applied after ploughing are best for reproduction in Mango. An extra ploughing during winter rains is advantageous.

60. Some Experiments on the Transmission of the Photo-Periodic Stimulus by Grafting in Jute.

J. C. Sen Gupta, Calcutta.

Clear evidences of the conduction of photoperiodic stimulus from photoperiodically induced plants to non-induced plants through grafts have been recorded in *Xanthium*, Soyabean, Beet and others and this has been taken as a strong evidence of the photoperiodic effect being associated with the production of substances of hormonal nature.

Some preliminary experiments were first tried to see how far Jute plants can be grafted successfully, and to find out whether the photoperiodic stimulus is transmitted from the induced donor plants to the non-induced receptor plants. The grafts were found to set without difficulty. Two types of graft, splice graft and contact or approach graft, were tried.

In Jute, a short day plant, induction has been found to take place on 21 days exposure to 10 hrs. light period.

Grafts were made between plants exposed to 10 hrs., 14 hrs. and normal light period for 21 days, in different combinations of two as stocks and scions in the splice grafts and as the two components in the approach grafts. The plants were exposed to 14 hrs, 10 hrs and normal light periods in different cases after grafting.

It was found that the light period to which the plants were exposed after grafting had the greatest influence on flowering. Except in one or two cases no indication of the transmission of the flowering stimulus from the donor to the receptor plant was found, on the other hand the flowering was found to be delayed in the induced donor plants on grafting with a non-induced receptor plant.

61. Relation of Rate of Respiration and Enzymic Activity during Ripening of Alfonso Mango.

D. B. MAHAJAN and U. K. KANITKAR, Poona.

Changes in the rate of respiration and activity of peroxidase, oxidase, catalase and phosphatase in mango fruit during ripening were determined. The climacteric set in at the and of 2 to 3 days. With the arrival of the climacteric enzyme activity was seen to change suddenly. The peroxidase shows a decrease in activity during and after climacteric while oxidase and catalase activity increased during the same period. The phosphatase activity however was high only during the climacteric until the fruit was completely ripe. It was low in both pre-climacteric and also in over-ripened stage. This leads to the conclusion that phosphatase is responsible for initiation of chemical changes during ripening of fruit and it remains very active only during the period concerned with these changes. It is further suggested that the changes in peroxidase, ovidase and catalase activity depend on the change in chemical constitution brought about by phosphatase.

62. Effect of Treatment of Inflorescencess on Mango with Growth Promoting substances on Growth of Fruit and Embryo.

U. K. KANITKAR, Poona.

Inflorescences of Alfonso, payari and Raival varieties of mango were treated with various concentrations of B indolyl acetic acid, naphthalene acetic acid and 2-4, D. The effects of these treatments were estimated by changes brought about in growth of fruit and embryo.

The three varieties tested gave differential responses to the substances used. In no case could these substances induce parthenocarpy.

B indolyl acetic acid and naphthalene acetic acid did not affect the growth of fruit and embryo in Alfonso and Payari varieties. Similarly 2-4, D did not induce any response in the Alfonso. In the Payari variety however the weight of the embryo was reduced by 37 .% under treatment with 10 ppm as compared to the untreated control, although there was no decrease or increase in the total fruit weight. The Raival variety was adversely affected by the application of 2-4, D as not only the fruit was much smaller but the weight of embryo was also reduced significantly.

The Effect of Pre-emergence Treatment with Hormonal Weedicides on the Weed Flora of an Uncultivated Field.

S. SOLOMON and M. V. V. RAO, Poona.

An uncultivated field was treated with three weedicides viz. Agroxone, Fernoxone and Weed-No-More. Three doses of each chemical were employed viz., 2 lbs. 4 lbs. and 6 lbs. of the active ingredients per acre. Periodical observations were made on the appearance of weeds and two months after treatment all the weeds appearing in the different treatments were pulled out and weighed.

It was observed that the number of weeds in the treated plots was considerably reduced, greater reduction taking place as the dose was increased. There was practically a complete suppression of grasses and dicotyledons in the treated plots. *Cyperus rotundus* was suppressed during the first month after treatment. But in the second month *Cyperus rotundus* plants appeared in large numbers until at the time of harvest there was more *Cyperus rotundus* in the treated plots than in the untreated ones.

As regards the three chemicals used, it was observed that all of them have the same effect. But in the first month after treatment, it appears that Fernoxone and Weed-No-More suppressed the weeds more effectively than Agroxone.

64. The Osmotic Pressure of the Host and Parasite in Relation to the Nutrition of the Host.

S. Solomon, Poona.

While studying the influence of nutrition of the host on the susceptibility of *Andropogon sorghum* to attack by the phanerogamic root-parasite *Striga lutea* and *S. densiflora* the hosts along with the parasites were grown in sand cultures watered by four different concentrations of the same nutrient solution for a period of nearly five months *i.e.* from sowing to harvest. These studies were utilised for testing the ability of the parasite to adjust its osmotic pressure to that of the host.

From the results obtained it was found that the severity of attack was the highest at the lower concentration and lowest at the higher concentrations of the nutrient solution. Similarly, the damage done by *Striga* plants as determined by the reduction in yield of grain of the *Sorghum* plants was the greatest at the lower concentrations. The differences in yields of straw were not significant.

The osmotic pressures of the leaves of *Sorghum* plants, attacked by *S. lutea* and *S. densiflora,* and of free *Sorghum* plants were determined by the plasmolytic method. The osmotic values of the leaves of the parasites were measured at the same time. It was found that the osmotic pressure of the parasite was always much greater than its host at the lower concentrations but at the highest concentration, the host and parasite have practically the same osmotic pressure.

65. On the Uptake of Nitrogen by Three Varieties of Wheat.

R. D. Asana and T. J. Malkhani, New Delhi.

With a view to understanding the physiology of varietal differences as regards the uptake of nutrients by crop plants, a study of the growth and uptake of nitrogen in three varieties of wheat viz. N.P. 165, N.P. 52 and N.P. 710, was undertaken. Two levels of nitrogen (control and nitrogen added to the soil) were maintained in this study which was carried out under pot culture. Plant samples were collected on five occasions during autogeny. Varietal difference in grain yield and ear number, at both levels of nitrogen, was not found to be statistically significant. Grain number per ear and maximum tiller numbers were significantly lower, at both levels of nitrogen, in N.P. 165. The smaller grain number in N.P. 165 and N.P. 710 was however, compensated by larger grain size. N.P. 52 absorbed a greater amount of nitrogen than N.P. 165 and N.P. 710. The rates of uptake of nitrogen by the three varieties were more or less similar up to the first 78 days, but between 78 and 118 days it was much higher in N.P. 52 and this largely accounted for the ultimate high nitrogen content of this variety. Active tillering phase was already over by 78 days. The only other difference between the varieties consisted in the larger number of spikelets and grains per ear in N.P. 52. There was thus a greater number of centres in the ear of N.P. 52 for protein synthesis and apparently more nitrogen was, therefore, absorbed. The percentage nitrogen centent of the grain of N.P. 52 was also the highest. All the 3 varieties responded equally well to nitrogen.

Ecology

66. The Importance of Geology in the study of Vegetation.

G. S. Puri, Dehra Dun.

The physical geology of a region affects the vegetation on the surface in two ways:—

(1) by presence or absence of minerals and

(2) by structural variations in rocks and nature of the slope, viz., dip versus scarp slope.

The effect of the first factor has long been appreciated both in this country, and in Europe. That of the second factor is put forward for the first time. It determine the availability of minerals at different positions on a single bed and also determines the maturity of topography and soils in a uniform climate. For example, on scarp slope the minerals will be leached to other areas by seepage through the strata of the rock; and topography and soils will tend to remain in an immature stage. The dip slope in contrast will correspond to an enriched area and soils topography here will be comparatively more matured. On account of the fundamental differences in the soils and topography the scarp and dip slopes will bear different types of vegetation whose demands on soil minerals and water will be different. Thus, broadly speaking, on quartzite, sandstone or phyllite formations in the Parbati Valley, non-exacting and xerophilous communities are found on scarp slope while compartively exacting mesophytic communities occuprred on dip slope.

67. Ecological Approach to the Problem of Sal (*Shorea Robusta*) Regeneration in the United Provinces.

Part II—The Foliar Ash and Cao in Sal and its Common Associates in the Dun Valley.

G. S. Puri and A. C. Gupta, Dehra Dun.

Mature leaves of 67 common species from reserved sal forests of Lachiwala, Thano and Kansrao, were collected during Sept.-Oct. 1949, air dried and powdered. Each sample was drawn from 9-10 middle-sized trees growing in an area approximately of 100 square feet. Ash was determined with bunsen burners after oven drying the samples for 2 hours at a temperature of 650 C. CaO was determined by the usual oxalate method.

It was found that there is a good deal of difference in foliar ash and Cao in different species growing within a small region under uniform climatic conditions. Foliar Ca is an index of physiological requirements of species and it determines to some extent the development of surface layers of the soil and seedling growth. The data are of importance in the study of regeneration of different species.

68. Maturity of Canes under Flooded or Water-Logged Conditions in North Bengal.

T. C. H. Singh, Annamalainagar.

Observations on canes have shown that flooded or waterlogged condition, induces early maturity almost simultaneously in all the canes whether early, medium or late. In North Bengal, canes like *Co*|*313*, *371*, *421* *527* and *331* were found to have matured fully in the flooded or water-logged areas of the districts of Rajshahi and Pabna as early as the first week of October a phonomenon unknown before! These observations were confirmed both under field conditions as well as under pot-culture experiments. Further the purity and MR of these samples was always found to be higher than that of samples derived from non water-logged areas.

69. Study of the Vegetation Found Round About Pilani.

B. N. Mulay and B. V. Ratnam, Pilani.

A list of plants occurring round about Pilani is given.

Typical sand plants belonging to the Chenopodiaceae, Salvadoraceae, Tamaricaceae and Euphorbiaceae and which are well represented in Sind and Western Rajputana floras, are absent from this locality.

Convolvulaceae and Verbenaceae are not well represented.

In Sind and Western Rajputana, October and November are the months for flowering for majority of plants. In Pilani most of the plants flower from July to September. This change of flowering time is most probably correlated with the favourable conditions for the germination of seeds.

In Pilani *Capparis—Prosopis* is the dominant association.

70. Sub-Alpine and Alipine Vegetation of the Sikkim Himalaya.

K. Biswas, Calcutta.

Since J. D. Hooker's visit to Sikkim a century ago—many botanists, mountaineers and tourists visited and collected plants from one of the world's best fields for sub-alpine and alpine flowers. Examination of these collections which are fairly large and good, however, show that it leaves much room for detailed study of the wonderful plants in and about the snowy regions of the Eastern Himalayas. In this region the Sub-alpine zone is generally well-marked between 8—10,000 ft. or say above 3,000 meters. The Alpines are seen in their best in the zone lying between 10 and 12,000 ft. that is at an altitude of roughly 4,00 meters. The zone above this is found to be of the nature "heath" formed by the smaller species of Rhododendron, Salix, Viburnums, Gentians, Primulas, and others and partly "subglacial fell-field with a mixture of herbaceous species." Results of my study of associations of these sub-alpines and alpines form the subject of this paper. Systematic enumeration of these species is also added to the paper.

71. Exchangeable Bases of Mangrove Soils.

F. R. Bharucha, and B. S. Navalkar, Bombay.

It was seen from previous investigations of various chemical factors of mangrove soils that neither pH nor Calcium carbonate nor the humus vary with the seasons or with different zones of the mangrove vegetation. These investigations failed to reveal the cause of zonation except perhaps that it is due to varying degrees of salinity or moisture of the soil. Therefore the reason for zonation was sought in another direction namely, in the exchangeable bases of the soil. Three distinct types of soils can be distinguished, each characterized by its own peculiar flora:

(*a*) The Ca-Mg Soil, with *Avicennia albea* as the predominating vegetation to the extent of exclusive covering by it;

(*b*) The Ca-Na Soil, characterised by *Acanthus ilicifolius* vegetation almost in pure stage;

(*c*) The Ca-K Soil, characterised by *Suadea fruticosa* vegetation and its few associated plants.

Hence it can be said that in determining associations the main considerations are the amounts of exchangeable bases present in the soils and therefore the exchangeable bases do seem to solve the difficulty of explaining differences in between various zones of vegetation.

72. Common Grasses Found Round about Pilani (Rajasthan).

K. R. Ramachandra, Pilani.

1. A list of grasses growing round about Pilani is given, with comments on ecological and other factors.

2. Typical psammophilous grasses found in the locality are *Cenchrus barbatus, Dactyloctenium aegypticum,* species of *Aristida, Eragrostis, Sporobolus* and *Saccharum.*

3. Mesophilous grasses, which are mostly annuals, occur around "pockets" of water collected during the rainy season, and in the sheltered spots beneath trees. Important among mesophilous grasses are *Paspalidium geminatum, Echinochloa colona, Brachiaria ramosa,* and *Urochloa panicoides. Digitaria marginata* may be included here, but it also occurs in the dry open "pastures."

4. Species of *Aristida* are not as abundant as could be expected, and *Heteropogon contortus* seems to be not represented at all. This is interesting in view of certain comments made by Burns, Kulkarni and Godbole (1928) on the distribution of the *Aristidas* in the grasslands of the Deccan.

73. Time of Application of Organic and Inorganic Manure on Rice.

A. K. KAR, Bankura.

An experiment was conducted at Rice Research Station, Bankura (lateritic tract) to find out the best time of application of Organic as well as Inorganic manure on rice. On Ajan 246, a transplanted low land Aman paddy which is very popular in the lateritic tract, two different kinds of manure (1) Organic—Mustard Cake (2) Inorganic Ammonium Sulphate, was applied at the rate of 40 lbs. Nitrogen per acre, during the three different times within the life cycle of the crop; (1) During puddling, (2) During weeding (*i.e.,* about one month after transplanting), (3) During Thormuck stage (*i.e.,* about a fortnight ahead of the emergence of inflorescence). The experiment was repeated *in situ* for three consecutive seasons with the identical design of Rendomised Block with six replications.

Highest yields of both grain and straw have been obtained with the application of both Organic and Inorganic manure during weeding (*i.e.,* about one month after transplanting) and they are significantly superior to the yields obtained by the applications during puddling and during Thormuck stage, which evidently indicates that the best time of application of both Organic and Inorganic manure is during weeding. With regard to grain yield the application of manure during puddling is significantly superior to the application of manure during Thormuck stage, whereas with regard to straw yield there is no significant difference between the said two treatments.

With regard to the quality there is no significant differenece in grain and straw yields between Organic and Inorganic manure.

74. A Note on the Grain Standardisation in Rice.

A. K. KAR, Bankura.

With a view to receive the nature of the rice grain of Rupsal type in the early, medium and late strains of transplanted Aus and Aman paddy crop suitable for Danga, Bad, Kanali and Shole lands characteristic of lateritic tract, selected strains of Ashkata (early Aus), Khiramungi (early Aman) Nonaramsal (medium Aman), Bhasamanik and Raghusal (Late Aman) were crossed with Rupsal at the Rice Research Station, Bankura. Rupsal is a transplanted Aman Paddy strain of fairly high yielding quality with fine white translucent grain of very high milling and cooking quality suitable for export trade. Hybrid crosses were studied upto F9 and the desired characters were established through subsequent selection and field trials. Almost all the hybrid strains are breeding true. Out of the hybrid crosses which are breeding true some of the strains of Ashkata X Rupsal, Khiramungi X Rupsal, Nonaramsal X Rupsal, Bhasamanik X Rupsal and Raghusal X Rupsal have already given promising yield with the standard Rupsal type of grain under field trials and the rest are still in the experimental stage.

75. Analytical Studies on the Plankton Periodicity of the Calcutta Water Supply Settling Tank.

HIMANSU KUMAR ROY, Calcutta.

This study was intended for finding out the probable chemical and physical factors responsible for the rapid growth and multiplication of the microphytoplankton flora, especially the diatoms, of the settling tank during some specific periods of the year. The highest yield of the settling tank plankton, mainly of diatoms, unlike that of the river water ones, is recorded during the maximum temperature period of summer, but at the same time, the same diatom genera have been found to occur in the settling tank with almost equal dominancy during both the high and low temperature periods. Also, there seems to be no significant correlationship between the plankton yield and the free ammonia, nitrite and nitrate content of the water which is found to be very low in these contents but for some special occasions. A record of comparatively lower content of these compounds in the settled than in the river water, however, goes to suggest that some amount of the simple nitrogenous compounds carried by the river to the settled water are used up by the phytoplankton of the settling tank. The association of a relatively higher rise of the nitrate content of the settled watter with a comparatively greater pulse amplitude of diatoms of the spring-summer months of 1946 and 1948, on the other hand, tends to point towards the nitrate content playing an important role in the determination of diatom periodicity. But the preceding and succeeding summer pulses do not seem to have much support for this interpretation. Assuming that this may be due to some other factors playing as a limiting one, a reference is made to the past records of silica content figures for comparison, as these were not collected during the three years of study, when actually a positive correlationship is obtained between the silica content and diatom periodicity. The extreme fluctuations in the absolute values of the silica content during the same season of two different years also suggests that this may be a reason of the relative differences in the intensities of the seasonal yields of diatoms of the different years; and it may be due to the combined effect of the increased nitrate content with silica, calcium and magnesium that there is a greater intensity of diatom yield of the settling tank during the spring-summer months when the silica content is comparatively lower than that of the winter months.

The record of the lowest albuminoid ammonia content during the months of september to november, when the Myxophyceae indicates a pulse on the periodicity curve inspite of the hardness and alkalinity due to bicarbonates of the water already going down, suggests that the blue green algae probably draws direct nutrition from the soluble organic matter set free by the decaying diatom cells during thit period.

Cytology and Genetics

76. Cytological Studies in Hydrocharitaceæ.

Y. SUNDAR RAO, Hoshiarpur.

A cytological study of Hydrocharitaceae has revealed the following diploid chromosome numbers: *Blyxa* spp., $2n$-16; *Hylrilla verticillata* Casp., $2n$-16; *Vallisneria spiralis* Linn., $2n$-20; *Ottelia alismoides* Pers., $2n$-22 and 66; and *Boottia* spp., $2n$-66.

In *Vallisneria spiralis*, the somatic chromosomes show distinct size variations and the chromosomes of the two sexes do not differ either in morphology or number. There are three pairs of long chromosomes with terminal constrictions, one pair of medium sized chromosomes, also with terminal constrictions and six short pairs with subterminal constrictions. One pair of chromosomes is nucleolar and though *Vallisneria* is a diploid on this basis, the ten bivalents at I metaphase show secondary association forming 3(2) + 4(1). If secondary association is a reliable guide to polyploidy, it probably had originated from a seven chormosomal ancestor. This is in accordance with the fact that the lowest haploid number reported so far in the family is seven and that *Lagarosiphon,* a close relative of *Vallisneria,* is characterised by it.

Blyxa spp., resembles *Vallisneria* in its vegetative characters but the floral construction is very different and so are the chromosomes. The sixteen chromosomes vary but little in size and possess terminal or subterminal constrictions. Like *Vallisneria,* however, there are two nucleolar chromosomes and there is no sex chromosome mechanism.

In *Hydrilla verticillata,* the karyotype consists of five long and three short chromosome pairs with median, sub-median and sub-terminal constrictions.

Ottelia alismoides has been found to be an extremely polymorphic species with diploid and hexaploid races having twenty-two and sixty-six somatic chromosomes respectively. Janaki Ammal reported a race with $2n$-ca 40 and is probably a tetraploid. The idiogram of the diploid race consists of one exceptionally long chromosome with almost a median constriction, seven chromosomes of variable lengths with median, submedian and sub-terminal constrictions and three short chromosomes with sub-terminal constrictions. In the diploid complement two chromosomes are satellited and correspondingly there are two nucleoli in the telophases.

Morphologically the polyploids are in distinguishable from the diploids but differ in geographic distribution. Plants collected from the Godavari district of the Andhradesa are diploid and those of the upper Gangetic plain are hexaploid. Again *Ottelia alismoides* in Bangalore is also polyploid as shown by the work of Murty. It looks as though that the diploids have a restricted range of distribution when compared with the polyploids.

The species of *Bootia* resembles *Ottelia* cytologically in having sixty-six somatic chromosomes in the root-tip cells. This provides a cytological confirmation for merging this genus in *Ottelia,* as advocated by Dandy.

In general it may be concluded with certain reservations that the karyotypes in Hydrocharitaceae have long median and short chromosomes, a feature found in many Helobiales and the intergeneric relationships can be explained on the basis of aneuploidy, genic and structural changes. Polyploidy has played but little part in speciation. It has been mostly helpful in extending the range of distribution of species as shown by the distribution of the inter-specific polyploids of *Ottelia alismodes.* The significance of polyploidy in the evolution of Hydrocharitaceae, particularly in *Ottelia,* requires investigation.

77. Somatic Chromosome numbers of some Wild and Cultivated Varieties of *Musa.*

S. GOVINDASWAMI, Poona.

A collection has been made of 18 wild and cultivated varieties of the genus *Musa* from different parts of India. Somatic chromosome numbers of the following have been determined:—

Sub-genus *Rhodochlamys* (1) *Musa rosacea,* $2n = 22$ & $21+1$ f. (2) *Musa rubra.* $2n =$ (3) *Musa dasycarpa,* $2n = 22$. (4) *Musa sanquinea,* $2n = 22$.
Sub-genus *Eumusa* (1) Ramkela, $2n = 22$. (2) *Musa textilis,* $2n = 22$. (3) Elvazhi, $2n = 22$. (4) Ennabenian, $2n = 33$. (5) Anai Komban, $2n = 33$. (6) Kallumonthan, $2n = 33$ and $33+1$ f. (7) Poovan, $2n = 33$. (8) Muskel, $2n = 33$. (9) Mutheli, $2n = 33$. (10) Lal Kel, $2n = 33$. (11) Lal Velchi, $2n = 33$. (12) Rajeli, $2n = 33$. (13) Basarai, $2n = 33$. (14) Safet Velchi, $2n = 22$ and $22+1$ f.

The varieties belonging to the sub-genus Rhodochlamys have $2n = 22$ & $2n = 22 + 1$ f. chromosomes, whereas the members belonging to this sub-genus Eumusa show two distinct lines of chromosome numbers namely $2n=22$ or $22+1$ f. and $2n=33$ or $33+1$ f. The seedless nature of the edible bananas is usually attributed to their tiploid chromosome constitution. In the present investigation it is observed that the varieties Ennabenian, Kallumonthan, Anaikomban and Poovan are really triploids although they are stated to be seeded. Similarly the variety Safet Velchi considered to be a good table variety has $2n=22$ chromosomes. This is being further investigated.

78. A Further Evidence on the Sex Chromosomes in Coccinia Indica.

L. S. S. Kumar, G. B. Deodikar, S. Vishveshwara, Poona.

The authors in their previous communication had reported the *xx* condition of male and *xy* of female in *Coccinia indica* and the nucleolar origin of the sex chromosomes. The present paper furnishes further evidence in support of the *xx* condition of the male supported by photomicrographs which provide incontrovertible evidence for the (1) nucleolar origin of the sex chromosomes in the male and (2) their complete morphological identity in respect of size and shape (*xx*).

During anaphase I, the *xx* pair shows precocious anaphasic separation associated with the formation of chromatin bridge due to the long persistent chiasma in the terminal regions of the short arm. The chromatin material for such a bridge may be contributed either equally by both the members or one of the members only. In the former case the two separating masses look equal in size but in the latter case they look unequal since the member which contributes to the formation of chromatin bridge looks smaller than the one which does not so contribute. Such gross superficial appearance has led some authors (Bhaduri, 1947) to wrong inferences regarding the heteromorphic condition of the male in *C. indica*.

79. Colchicine Induced Polyploids in Linseed.

Hari Kishore and N. Parthasarathy, New Delhi.

Work in progress at the Indian Agricultural Research Institute, New Delhi on induced polyploidy as a method of crop improvement has indicated that the initial materials must be as varied as possible for treatment. The autotetraploids generally have varying degrees of sterility and it has been found possible to obtain more fertile plants by selection in hybrid progenies.

In view of the above, work on linseed was started in 1948-49 by taking up six high yielding rust resistant strains evolved at the Indian Agricultural Research Institute for treatment with colchicine. The application of this chemical in aqueous solution to the young growing tips above the cotyledon gave the best results.

The tetraploids obtained showed comparatively gigas characters in stomata, pollen, anthers, capsules and seeds. There was variation in seed setting from 1 to 7 seeds per capsule while the average for diploids was seven. Selections were made among the tetraploids of different strains for high seed setting. The problem of sterility may not be a serious factor in this crop. However, breeding behaviour of these tetraploids in respect of chromosome number remains to be investigated. The study of meiosis in pollen mother cells revealed that at metaphase I, 4 to 14 quadrivalents are formed, but the disjunction of the chromosomes was observed to be normal.

80. Studies on the Cytogenetics of Mango.

Basudev Roy, Poona.

From cytological studies of 15 varieties and seedlings of the cultivated mango namely (1) Alphonso (2) Amini (3) China No 1. (4) Gadhmar (5) Kalkhand (6) Lal Pairi

(8|19 G. B. G.) (7) Malgoba (8) Pairi (9) Romani (10) Roos (11) Shendraya. (12) Seedling No. S. N.|1 (13) Seedling J. M.|1 (14) Pai Posha and (15) a local variety collected by Prof. S. P. Agharkar from Narayangaon, Poona District, it has been observed that all of them except the Seedling No. S. N.|1 possess $n = 20$ or $2n = 40$ chromosomes. The seedling No. S. N.|1 has got $n=21$ chromosomes which seems to be an aneuploid form.

Midnight fixation of root tips showed greater frequency of cell division than that in day-time.

Mango varieties may be classified into groups on the basis of such characters as (*i*) presence or absence of beak, (*ii*) presence or absence of the ventral cavity, and (*iii*) presence or absence of the shoulder etc.

Occurrence of mericlinal chimaera has been observed in some grafted mango trees of Alphonso and Portia varieties.

81. A Preliminary Note on the Cytogenetic Survey of the Genus *Commelina* In India.

G. B. Deodikar, Poona.

Over 25 species together with a large number of ecotypes collected from various parts of India, Burma and Ceylon, their intraspecific and intervarietal polyploids and a natural interspecific hybrid, have been included in the present investigations.

Observations have been recorded on (1) chromosome size and morphology, (2) analysis of meiotic conjugation, (3) nucleolar chromosomes, (4) secondary associations, (5) distribution, (6) structural changes in chromosomes, (7) morphological differences, (8) taxonomic affinities, and (9) geographical distribution.

Evidence from all these relevant lines, leads to the conclusion that there are two polyploid series in primary and secondary chromosomal balance with 8 and 16 as their respective monoploid numbers.

All species are characterised by a range of variation in their chromosome number, which increases with the increasing polyploidy. *C. nudiflora* shows intraspecific autopolyploid series ($n = 8$, primary) and *C. obliqua* shows intervarietal polyploid series $n = 16$, secondary) up to Octapliod.

Species in primary chromosomal balance show maximum distribution with high diversity in Ceylon and Peninsular India. Species in secondary chromosomal balance increase in the northern direction. Central India and the Deccan Traps show a mixed distribution.

82. The Riboflavin Excreting Mutant and the Problem of Variability in Yeasts.

B. Ranganathan and M. K. Subramaniam, Bangalore.

Artificially produced top yeasts appear to be autotrophic and aerobic and excrete into the wash considerable amounts of riboflavin. The possibility that these may be highly useful for Compressed Yeast Manufacture necessitated a consideration of the problem of stability in yeasts.

Investigators subscribe to the belief that yeasts are unstable. The problem of stability has received only scant attention and no previous attempt has been made to discover methods to induce stability. Literal acceptance of the above view would not only invalidate the classification of yeasts into species and genera, but would also leave unexplained why the strains used in industry are highly stable.

Systematic observations of the changes in the sculpturing of the giant colonies of the top yeasts extending over two years indicate only a waxing and waning of the size of the rough rim during different seasons when cultured at the room temperature.

This waxing and waning of the sculptured rim parallels the predominance of the rough and smooth types of colonies in the control, which have already been interpreted as the result of mutations to different alleles at the locus determining the nature of sculpturing. Since the top yeasts appear to be the result of a chromosomal translocation, the genic sequences should have been altered and as a result the mutations at the loci governing the nature of sculpturing should produce phenotypic expressions entirely different from that observed in the control. Tetraploids are highly stable and industrial types should be polyploids.

Induction of polyploidy is a possibility and hence the question of stability ceases automatically to be a nightmare to the practical breeder.

83. Alleles and their time of Expression in Yeasts.

M. K. Subramaniam, Bangalore.

The various types of sculpturing observed in giant colonies of the two-chromosome brewery yeast could be classified into distinct types in an ascending grade of complexity. This classification is shown to be a natural one on the basis of observations on types exhibiting finally a complex sculpturing.

The simpler types appear as orderly stages during development of the complex ones. Photographs illustrating such stages are given from two strains isolated after ultra violet irradiation and having different early histories.

The same types could be recovered year after year and the failure of the early workers in this direction may be due to a lack of realisation of the effect of the environment on genic expression in giant colonies.

The multiple alleles occurring at the locus governing the nature of sculpturing appear to be related to one another as hypo-and hypermorphs. It is indicated diagrammatically how with increasing complexity of final expression, the earlier types are not only pushed farther and farther back, but that there is also a corresponding shortening of the time of duration of each stage.

84. Effect of Chromosomal Duplication on the Alcohol Tolerance of a Brewery Yeast.

S. Duraiswami, Bangalore.

The question whether duplication of chromosomes alters the alcohol tolerance was investigated in view of the fact that such a duplication resulted only in a quickening in the rate of fermentation and not in the quantity of the final product.

Alcohol tolerance has to be redefined as that concentration of alcohol by weight above which the percentage of sugar utilised falls below 90%.

Cells grown under various environmental conditions showed differences in their alcohol tolerance. The remarkable fact, however, was that under all the conditions studied the tetraploid had a higher alcohol tolerance than the diploid.

85. Fermentative Ability of the Riboflavin Excreting Mutant Yeast.

K. K. Mitra, Bangalore.

A recent observation showed that the top yeast mutant obtained by the treatment of a brewery bottom yeast with acenaphthene for 90 days is endowed with the property of excreting a large amount of riboflavin into the culture medium. Since riboflavin is known to play an important role in the form of the flavo-proteins in the respiratory and fermentative processes, it was thought interesting to investigate the fermentative characteristics of the control and the mutant strains on a comparative basis. It was found that the mutant, unlike the control, is unable to ferment glucose, fructose, galactose, maltose and sucrose. It has been suggested that this loss in the fermentative power in the case of the mutant may be correlated with its property of excreting the synthesised riboflavin. It appears as though as a result of a chromosomal translocation the strain has lost the capacity to bind up the riboflavin in the form of the enzyme systems responsible for fermentation.

Paleobotany

86. Fossil Microflora from the Mohgaon-Kalan Beds on the Central Provinces.

S. D. CHITALEY, Nagpur.

This paper deals with the fossil microflora from the Tertiary beds of the Central Provinces, exposed near a village, Mohgaon-Kalan in the Chhindwara district.

For the maceration of the cherts, Schulkze's maceration fluid (HNO_3 & $KCLO_3$) was first tried, but found to be fruitless. Later on, the other method of the HF treatment was used, which proved to be quite successful in crumbling the rock.

Description of twenty five different kinds of spores and pollen grains is given in the first part. Out of these a few belong to Pteridophytes or Gymnosperms and the rest to Angiosperms.

In the next part, the following organic remains are recorded:—

> Two types of vascular elements, one with bordered pits on the wall and another with spiral thickening; an unicellular hair with a pointed knob at the end; a piece of leaf cuticle with short, sinuous walled cells; another piece of cuticle probably of Gramineae, with sinuous walled, alongated cells and dumbel shaped stomata and a few epidermal outgrowths of unicellular pointed hairs.

As the pollen grains showing closest resemblance to those of Lythraceae, Myrtaceae, Palmaceae, Rosaceae, etc., are identified in the above study, it is suggested that the microflora from these beds may in all probability give a corroborating proof to the late Prof. Sahni's view, saying that they are Eocene.

The microflora from this bed is described here for the first time in detail except when recorded by me in the "Palaeobotany in India", Nos. 6 (1947) & 7, (1949). *in press.*

87. Plant Impressions from the Coal Measures of Southern Shan States (Burma.)

B. S. TRIVEDI, Lucknow.

In this paper are described only a few well preserved plant remains from amongst a large number of impressions which were examined. *Scleroptaris furcata* Halle, *Sphenopteris rotundiloba* Saporta, have well preserved impressions. They have been reported for the first time from this area. Three imperfectly preserved species of *Sphenopteris* and three species of *Zamites* besides a number of other unrecognizable plant remains have been described.

The rocks have been metamorphosed so that many of the impressions have been obliterated. This change has affected the microfossils as well, with the result that neither a cuticle nor a single spore could be recovered. On microscopic examination only small, structureless, carbonised pieces are visible.

The palaeobotanical evidence tends to support a mid-Jurassic age for the coal measures as was proposed earlier by Cotter in 1922.

88. Search for Microfossils in the Purple Sandstone, Salt Range, Punjab.

A. K. GHOSH AND A. BOSE, Calcutta.

Hsü (*Proc. Nat. Acad. Cc.* B, *16*, 92, 1946) failed to recover any microfossils from these beds from a few samples examined by him. Sahni (*loc. cit*), remarked "It must of course, be admitted that this negative evidence from a few samples does not necessarily mean that the rocks are unfossiliferous, or indicate beyond doubt that they are of very ancient dates".

An examination of a sample (G.S.I. No. 5226) from North of Chenki, Jabbi, Salt Range, yielded a few microfossils and reported earlier (*Proc. 35th Ind. Sc. Congress*, part 3, *Geo. & Geog. sec.* 1948).

Further examination of samples from Warcha gorge on the eastern slope north of Salt Chauki, yield carbonised and non-carbonised pieces of wood showing uni-multiseriate pits, scalariform and bordered pitted tracheids; cuticles with or without stomata; a few spores; insect remains and other unidentifiable vegetable matters. The total number of microfragments recovered from surface samples are 171 and that from samples 1 ft. inside are 109.

The occurrence of such characteristic and well formed parts of terrestrial flora in the 'Cambrian' age and its bearing on the age of the underlying Saline Series and phylogeny of vascular plants are discussed.*

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SECTION OF AGRICULTURAL SCIENCES

President: R. L. Sethi, I.A.S.

1. Rainfall in Relation to Agriculture and Population in Yeatmal District.

BHALCHANDRA K. BIDVAI, Amaraoti.

The paper attempts to correlate certain Physical and Human facts in the Yeatmal District of Berar.

The annual rainfall in the District is about 38 inches of which the summer monsoon contributes 87 p.c. The rest of the year is mostly dry. Agricultural activities are well adjusted with the normal distribution of rainfall on which also depends the prosperity of the people. But there is often a great variation. A comparative study of typical years reveals that a wide departure from the normal appears to be not beneficial to agriculture. The failure of rains in September and October is especially harmful. That is why 1906 and 1907 were years of Scarcity and 1896, 1899, 1918 and 1920 of famine.

Malaria is most prevalent when rain fails is September and October but for which the District is quite healthy. The best decade from the point of view of health was 1901-1910 and the worst 1891-1900.

The paper concludes that the distribution of rainfall is of greater significance than the amount and the failure of rains in September and October adversely affects agriculture and the health of the people in the District of Yeatmal.

2. Refrigeration Experiments on *Trichogramma Evanescens Minutum* Riley, an Egg Parasite of the Sugarcane Stem and Root Borers.

T. V. VENKATRAMAN AND M. L. GOVIL, New Delhi.

The effect of refrigeration on the viability, longevity, fecundity and sex ratio of the well-known egg parasite, *Trichogramma evanescens minutum,* was undertaken to find out if the eggs of the host (*Corcyra cephalonica*) *parasitised* by *Trichogramma,* cannot be successfully held in the Frigidaire at a temperature of 10° to 12° C for any great length of time.

Viability experiments to determine the percentage surviving showed that (*i*) the average percentage of viability decreased gradually as the period of refrigeration was increased, and (*ii*) up to 15 days, refrigeration, the viability was not adversely affected.

Refrigeration of the parasitised eggs affected the longevity of adults, depending on the period of cold storage. Results of a comparison of longevity of adults mating and laying eggs, and non-mating and not laying eggs showed that (*i*) there was practically no difference in the longevity in both cases up to 15 days, and (*ii*) the longevity in both cases was not affected adversely up to about 15 days of refrigeration.

Experiments of the fecundity of the parasite have shown that the number of eggs laid by a female decreased as the period of refrigeration was increased. It has been shown that the parasitised eggs, 4 days after parasitisation, could be successfully stored for a period of 15 days, at a low temperature of 10°—12° C, without impairing the fecundity to an appreciable extent.

The effect of refrigeration of parasitised eggs on the sex ratio was not in evidence up to about 10 days of refrigeration, Beyond this period there was a gradual increase in the percentage of females, the average percentage being 61.2 after 25 days of refrigeration.

The results have clearly shown that parasitised *Corcyra* eggs, four days after parasitisation, can withstand successfully a period of 15 days refrigeration (temperature 10°-12 C: Relative Humidity, 70-90%) without appreciably affecting the viability, longevity, fecundity and sex ratio. The practical importance of these findings need hardly be emphasised.

3. Isolation and Purification of Datura "Distortion" Mosaic Virus.

S. P. Capoor, Poona.

A virus disease of *Datura albe* Nees. was discovered in 1939 and designated as "distortion mosaic" of *Datura alba* in 1948 (Curr. Sci. *17*: 151).

The virus, though thermolabile (inactivated at 60° C. in 10 minutes), sensitive to ageing (longevity *in vitro* 13 days) and not present in high concentrations in the host plant (dilution end point 1 x 10^{-4} withstands treatment with 95% ethyl alchohol for over 30 hours at low temperature.

For virus purification, juice from leaves of diseased *D. alba* plants was extracted by grinding the leaves fresh in a laboratory mill and the pulp strained through cloth. A second extraction was made with some crystals of K_2HPO_4 and distilled water. The two extracts were mixed together and to it enough 95% ethyl alcohol was added to make a 50% alcoholic solution. On standing at 40°F., the coloured precipitate which formed was removed by centrifuging. Three-fourths by volume of 95% alcohol was then added to the clear supernatant fluid. This precipitated all the virus, which was spun down within 20 minutes at 3,500 r.p.m. The precipitate was then taken up in distilled water equal to one fifth the volume of original sap, and its H-ion concentration adjusted to pH7 by dilute NaOH. Further purification was done by acid and ammonium sulphate. All purification procedures were carried out at about 45°F.

The purified virus solution was opalescent and highly birefringent when shaken between crossed polaroid plates and showed anisotropy of flow visible to the naked eye. The virus, which is isoelectric at pH 4.5, forms long rod-shaped paracrystals at pH 5.5 and aggregates into small spindles on further concentration. True crystals are, however, not formed and it remains in a liquid crystalline state. The purified preparation was mostly free of any pigmentation as confirmed by the visible spectrum photograph. It also gave biuret, Mollisch's and Millon's reactions. Work on other properties of the virus protein is in progress.

4. *Xanthomonas Badri* in Nov. Sp. on *Xanthium strumarium* L. in India.

M. K. Patel, Y. S. Kulkarni and G. W. Dhande, Poona.

A bacterial leaf-spot on *Xanthium strumarium,* a weed commonly found in low lying areas all over India, was noticed near Government Farm, Jalgaon, in August 1948. Search through literature revealed no mention of any bacterial disease on this host and since it differs from the bacterial pathogenes so far known, it is considered to be new to science.

The pathogen enters the leaf through hydathodes and produces irregular, pale yellow, spots on the leaf-borders. The spots gradually increase in size when the central portion of spots becomes deep-brown accompanied by a yellow border. In severe cases of attack, the entire leaf-border gets infected and the leaf shrivels. Under ideal conditions of humidity and temperature, the infection becomes systemic as the organism migrates to the leaf-veins and makes its way as far as the steam through the leaf-petioles. Wilting of young plants from top downward is not uncommon.

Description of the Organism: Short rod, single or in chains, gram-negative, not acid fast, non-spore former, motile by a polar flagellum and measures 1.59 μ x 0.83 μ

On potato dextrose agar plates, colonies round, smooth, glistening, capitate with entire margins, 0.8 to 1.0 cm. in diameter after 4 days, colour empire yellow; on nutrient agar plates, colonies smooth, glistening with entire margins, 7 mm. in 4 days, the inner 6 mm of the colony pale yellow while the outer 1 mm. border of the colony empire yellow; gelatin liquefied; casein digested; starch attacked; litmas reduced in 8 days; acid but no gas in dextrose, lactose, mannitol, salicin and sucrose; M.R.V.P. tests negative; nitrites and indol not produced; ammonia produced; Loeffler's blood serum slowly liquefied; thermal death point about 51°C.

Pathogenic to *Xanthium strumarium and peas* (*Pisum sativum* L.) only.

5. The Inheritance of 'Dwarf' Mutants in *G. Arboreum* race *Indicum.*

R. Balasubrahmanyan and Santhanam, Madras.

The genetics of four dwarfs recorded in G. *arboreum race indicum* is summarised in this note. They are (a) Coimbatore dwarf (b) Coconada dwarf (d) Anakapalle dwarf and (d) '1767' dwarf. All the types were characterised by short internodes and the last three by a lower number of nodes than the normal, the cumulative effect of both being dwarfing. Coimbatore dwarf behaves as a monogenic recessive to normal in both *arboreum* and *herbaceum crosses.* 'Anakapalle dwarf' is a simple recessive to normal while it behaves as complementary to Coconada dwarf. Lint colour and plant habit are inherited independant of one another. The F2 distribution of the cross '1767' dwarf x Coconada dwarf is observed to present a unimodal curve with no segregation and with its mean about that of the parents. They represent possibly independant mutations at the same locus, but carrying different complex of modifiers and provide an interesting instance where two degenerative recessives when intercrossed manifest heterosis. The gene symbols *db*, *dc*, and *dd* are given to Coimbatore dwarf, Coconada dwarf and Anakapalle dwarf respectively as per accepted convention (Hutchinson and Silow, 1939) while Venkoba Rao and Ramachandran's (1943) *herbaceum* mutant may be designated *da*.

6. The Inheritance of Lint Colour in Coconadas Cotton.

R. Balasubrahmanyan, V. Ramaswamy Mudaliyar and
V. Santanam, Madras.

The task of evolving a suitable strain for the Coconada area, combining both length and colour, led to the study of extensive crosses to break up short staple—colour association. The relevent aspects of this study pertaining to inheritance of lint colour and its relation in metric length in seven crosses involving white and coloured pure lines of the area is summarised in this note. The white linted Coconada pure line of the area is 45 is a simple recessive to Khaki A9 (LcK1). Strain Coconadas 1 carries the very light brown gene LcV2, while the behaviour of the deeper coloured pure lines

'123' and '129' suggests their probable genotype as LcB2. Nanking Khaki behaves as a smile dominant over Coconadas 1 (LcV2) indicating that it carries a darker allele at the same locus and the parental and F1 grading admit of an LcK2 postulate. G 1037 and G 1019 exhibit a bifactorial difference with Coconadas 1, confirming their genotype as LcK1. The affect of environment on the colour expression and fadding is stressed. A study of the association between length and colour reveals a uniform reduction in the length of brown segregates in all the hybrid progenies. The importance of the genic status of the Coconada area is indicated.

7. Systematics of a New Species of Aphis from Poona (Aphididae).

H. L. KULKARNY, Poona.

During May 1949, young shoots of *Phyllanthus emblica* were noticed badly damaged by aphids.

This aphid has revealed following interesting features.

(1) In the alate viviparous females the cubital vein in the fore-wing is only once branched as in genus *Toxoptera.* However, the second pair of wings are totally reduced into elongated structures. Secondly, the veins are smokey as in the genus *Pentalonia.*

(2) The cornicles and cauda are very characteristic. Cornicles are truncated as in genus *Therioaphis,* but the cauda is not knobbed nor is the anal-plate bilobed. Besides, the body of both the alate and apterous forms does not bear capitate hairs but on the contrary smooth as in genus *Aphis.*

(3) Antennae are only 5 segmented, the flagellum of the termin segment being very short.

(4) The head is as in genus *Aphis.*

This aphid has not been previously recorded in this country. The author thinks that it can very well be classed separately on account of the characteristic features not recorded so far, by previous workers.

8. Effect of Buttress Grafting on Growth and Development of Orchard Trees.

S. R. GANDHI, Poona.

The rejuvenation of the tops of ancient historic trees by buttressing their decaying trunks by inarching young seedling rootstocks of the same family is a well-known horticultural practice employed in all civilised countries of the world. In Bombay Province, it is being employed on healthy mango trees as a regular orchard practice with the same object. Its application is however indiscriminate, the inarch being applied not only to the scion trunk of the tree but also to its stock part and individual branches.

The author's investigations indicate that the ultimate physiological effect of buttressing the scion trunk amounts to the gradual replacement of original roots of the tree with new ones. Buttressing the stock results in an additional competitive root system which does not contribute towards the better development of the scion top. Butteressing the individual branches of a tree means dividing its top in so many independent subtrees which behave differently from one another and the parent top, in growth and development. To rejuvenate a sickly orchard tree, the inarch or buttressing root-stock hsould be applied to its scion trunk. Buttressing a healthy orchard tree is a wasteful practice which does not at all invigorate its top.

9. A Study of the Digestibility of the Proteins of Gram Varieties.

V. S. ABHYANKAR, M. S. NAIK AND J. A. DAJI, Poona.

Two varieties of gram, *chafa* and early *gulab*, have been evolved as improved strains from the local one. *Chafa* is a high yielder while early *gulab* has better parching quality compared to the local gram. The present paper deals with the digestibility of their proteins when subjected to the action of pepsin and trypsin *in vitro*. It is found that *chafa* gram is superior to early *gulab* or local variety.

10. A note on the Experiments on manuring of Grass Land at Palghar Bombay Province.

G. K. ZENDE AND O. G. KUNDALKAR, Poona.

A manurial experiment involving two doses of Nitrogen (30 and 60lbs. of Nitrogen per acre) in the form of F. Y. M., Groundnut cake and mixture with Sulphate of Ammonia, alone and in combination with superphosphate supplying 40 lbs. P_2O_5 per acre, was carried out on grass land at Palghar from 1946 to 1948, with a view to study the effect of these manurial treatments on the yield and nutritive value of grass as grown in nature.

The analyses of the results have brought out the importance ofstudying, not only the response of the yield of a crop to a particular manure in the presence of other factors (manures) on the average, but also its study in the presence of each of the constitutents separately. Thus, in the present experiment, the average response of the yield of grass to superphosphate is 9 lbs., per lb. of P_2O_5 per acre in the absence of Nitrogen, while it is as high as 34 lbs. in the presence of Nitrogen. Furthermore, the response to superphosphate is different in the presence of different kinds of Nitrogen, being 44 lbs. in the presence of groundnut-cake, while it is as low as 14 lbs. in the presence of F. Y. M. The same tendency is exhibited in the case of mixture with Sulphate of Ammonia; the average response to superphosphate in the presence of Groundnut-cake + Sulphate of Ammonia and F. Y. M. + Sulphate of Ammonia, being 53 and 25 lbs. per lb. of P_2O_5 per acre respectively.

The addition of superphosphate has also improved the quality of grass, by increasing its lime content and phosphoric acid content and decreasing the ratio of the two factors.

11. Relative Utility of Different Phosphatic Fertilizers in Four Typical Soils.

D. L. SAHASRABUDHE AND V. K. LELEY, Poona.

The utility of (i) Rock phosphate (ii) tricalcium phosphate (iii) superphosphate (iv) ammonium phosphate (v) bone meal and (vi) groundnut cake is compared in four typical soils namely (i) lateritic soil from Belgaum (ii) black soil from Dharwar (iii) *goradu* soil from Nadiad and (iv) medium black soil from Poona. The fertilizers were added to the soils and the samples were kept in moist condition for four months. The phosphate supplying power and the total extractable phosphate were then determined, using a saturated solution of carbonic acid as an extractant. These results are used as a basis for the comparison.

It was found that the utility depends firstly on the nature of the soil and secondly on the nature of the fertilizer. Superphosphate gave highest results in all the four soils. Next in order followed calcium phosphate, ammonium phosphate, groundnut cake, bone meal and rock phosphate.

Soils from Dharwar, Nadiad and Poona retain a greater quantity of phosphates in a soluble condition than the lateritic soil from Belgaum. Superphosphate appeared to the better suited to the last soil.

12. Studies on the Storage of Mosambi Fruits Wrapped in 'Pliofilm'.

S. R. Gandhi, J. A. Daji and V. K. Leley, Poona.

Pliofilm is a transparent packing material, prepared essentially from rubber hydrochloride. It is almost completely impermeable to Water vapour but allows a free diffusion of other gases like carbon dioxide, oxygen etc. It is ideally suited for wrapping fruits, vegetable etc. The work reported below is undertaken to give a trial to the material under the tropical conditions prevalent locally. *Mosambi* fruits (Citrus sinensis) were selected for study.

Fruits wrapped in pliofilm were kept at room temperature (80°F) and also in cold storage at 42°F alongwith fruits without wrappers to serve as control. External appearance, loss in weight of fruits, and chemical composition of the juice were recorded periodically for three months.

Fruits without wrapper lost marketable appearance within two weeks. They dried and became hard after six weeks.

Loss in weight during the period amounted to about 30 per cent. Fruits without wrappers keep better in cold storage. They were marketable for about two months. Total loss sustained by these fruits during three months amounted to about 24 per cent.

Wrapping in pliofilm considerably increased the storage life of the fruits both at room temperature and at 42°F. In either case the fruits were marketable even after three months. At room temperature they lost about 14 per cent of their weight during three months. The corresponding loss in the cold storage was only 15 per cent.

Chemical composition of the juice was not found to change appreciably in wrapped fruits as compared to the unwrapped.

13. Origin of Adventitious Roots in the Stem of Mulberry (*Morus indica.*)

D. B. Surti, Poona.

The paper gives an account of the author's study in the origin of adventitious roots in the stem of Morus indica which when planted as a stem cutting gives rise to wound roots from the basal cut and also to morphological roots from definite points in the nodes of the stem. Miscroscopical examination of the nodal structure revealed that three distinct morphological roots emerged from leaf gaps caused in the vascular cylinder by the departure of three leaf traces which supplied the leaf.

These gaps bridge the cortex and pith by a parenchymatous tissue which becomes meristematic half way along the longitudinal extent of the gap and gives rise to morphological roots. The transverse section through the internodal regions, however, did not reveal any dormant root initials which would give rise to morphological roots. Wound roots given out from the basal cut bore no relationship with the anatomical structure of the stem. They arose endogenously after formation of new vascular tissue in the basal callus from a meristem which is a continuation of the cambium.

14. Effect of 24 Dichlorophenoxy Acetic Acid on Germination in *Sorghum vulgare*.

V. K. Desmukh and U. K. Kanitkar, Poona.

With the broader object of investigating the efect of plant growth substances on Indian Crops, preliminary experiments were performed with 2.4 Dichlorophenoxy acetic acid on *Sorghum vulgare*. The seeds were treated with the substance in watery solutions at various concentrations viz. 2ppm, 10 ppm, 100 ppm and 600 ppm. The time of treatment was varied from 5 minutes to 24 hours. The seeds after treatment were thoroughly washed with water and were then germinated on moist filter paper and in soil.

In Jowar No. 8, the strain used for this investigation, treatments with 100 ppm. for 5 minutes and 10 ppm for 2 hours accelerated the growth of seedlings in soil, as estimated at the end of 15 days. On moist filter paper 2 ppm, 10 ppm and 100 ppm for two hours showed a similar effect in ten days. In all cases treatment with 600 ppm. for any length of time was seen to retard the growth of seedlings. It could also be seen that the treated seeds show a lesser activity in initial stages of germination than the untreated in both cultures. They however, grew faster than the controls, equalising with them within 7 to 10 days, and surpassing them in 10 days in water and in 15 days in soil. It is considered that the treatment increases the rate of growth of the seedlings probably by affecting their internal metabolism.

14. Economics of Anaerobic Fermentation of Cattledung.

N. V. JOSHI, Poona.

Dual use of cattle-dung by fermenting it anaerobically for the simultaneous production of fuel gas and manure was suggested by me at the science congress in 1945. The construction of the plant designed for the purpose for the individual use of cultivators requires an initial outlay but no current expenditure for running it, as the work is carried on by the peaceful activities of micro-organisms. The estimated values of the two products from the installation of such plants, if used on a country-wide scale, as well as, on an individual basis are given in the form of tables. These tables bring out the difference in the value of products obtained according to the present and the proposed new method of ultilising cattledung for manure and fuel. This difference in value being known, we can easily judge and decide on the initial outlay required for installing such plants.

16. Preliminary Studies on the Comparative Trials to Test the Instanteneous Susceptibility of Alate and Apterous forms of Certain Common Insect Pests to Benzene Hexachloride as a Contact Poison.

G. M. TALGERI, Poona.

Though several workers all over the world have carried out experiments to determine the toxicity of benzene hexachloride against different species of insects, no effort seems to have been made to find out whether this insecticide affected the alate forms of certain insects more than the apterous forms. The present paper details the results of experiments conducted in the direction.

Tests were carried out with 5 per cent BHC (0.65% gamma isomer) against aphids (*Myzus* spp., *Rhophalosiphum* spp. and *Macrosiphum* spp.) particularly on peas and crucifiers, red ants (*Oecophylla smaragdina*) infesting mango and citrus trees, winged grass hoppers (*Hieroglyphus banian*) affecting the paddy crop and Deccan Wingless grasshopper (*Colemania sphenariodes*) on jowar crop. Besides in order to study the relative susceptibility of adult and immature stages of certain hemipterous insects with no apterous forms, mango jassids (*Idiocerus* sp.) and sugarcane leafhoppers (*Pyrilla* sp.) were tested with this insecticide. The insecticide was applied with rotary hand dustgun at the rate of 25 lbs. per acre. The various tests were carried out by confining the infested plants or plant parts in wire gauge or cloth cages of different dimensions.

The relative susceptibility among different insects to 5 per cent BHC seem to vary considerably. Thus in vegetable aphids, about 80.1 per cent alate forms succumbed within an hour of treatment as against 19.2 per cent in apterous forms. In red ants (*Oecophylla smaragdina*), on an average 100 per cent susceptibility was noted in alate forms and only 32.2 per cent in apterous forms. Among the two species of grasshoppers however, the highest mortality of 94.5 per cent was observed in paddy winged grasshoppers (*Hieroglyphus banian*) and least in Deccan wingless grasshoppers (*Colemania sphenarioides*). In insects where there is no apterous stage as such, the susceptibility in adult stage (winged) was found 42.6 per cent and 56.5 per cent in mangohoppers (*Idiocerus* sp) and sugarcane leaf hopper (*Pyrilla* spp) respectively. The nymphal stage of these however was comparatively least affected.

Thus all these results show that the winged forms and species of certain insects are definitely more susceptible to 5 per cent benzene hexachloride than the wingless ones. However further observations in this direction are in progress.

17. Chemotropic Response of the Caterpillars of Amsacta Sp. to a Fermented Bait of *Thoria* (*Euphorbia nerifolia*) Leaces and *Mowhra* (*Bassia latifolia*) *Molasses.*

G. M. Talgeri, Poona.

The time honoured methods of controlling the *Amsacts* sp. caterpillars, being not very satisfactory, the needfor evolving new methods was felt quite essential. The chemotropic response of these caterpillars to fermented food material was therefore taken advantage of and a new bait containing four parts by weight of *thoria (Euphorbia nerifelia)* leaves and one part of *mowhro (Bassia latifolia)* molasses, was devised.

The bait was broadcasted along the borders of infested *bajri* fields at the rate of 20 lbs. per acre and counts were taken every day of the total number of caterpillars feeding on the bait and plants as well, in six sampling units of each 10′ x 10′, selected at random per replication. It was observed that there was a progressive rise in the number of caterpillars attracted to the bait, as the bait fermented more and more. Simultaneously, there was a proportionate decrease in the number of caterpillars feeding on the plants. Thus at the end of one week, the average number of caterpillars feeding on bait in one unit area was 390.6 and only about 27.5 on the plants in that area.

The caterpillars feeding on the bait could be easily destroyed by passing a stone roller over the bait once in four or five days, when the maximum number was attracted. The cost of baiting in one acre of *bajri* or maize for a week was about Rs. 2-8-0.

This bait was much superior to the one previously tried by the author with the addition of sodium fluosilicate, which definitely rendered the bait less attractive and probably less palatable to the caterpillars.

However, further work to improve the efficacy of the bait, which opened a new line of research, is in progress.

18. Large Scale Operations against Plant Diseases in India.

B. B. Mundkur, New Delhi.

Large scale operations against plant diseases have recently been initiated in several provinces in India. In starting such operations, attention is at present given to food crops alone and to diseases which can be easily or quickly controlled by approved and scientific methods. Commercial and cash crops are at present not included in this programme, though such operations have been undertaken by the industry in the case of coffee, tea and arecanut diseases.

19. The Seasonal Variation in Nitrogen Contents of Goradu Soils of Gujarat.

C. C. Shah, B. M. Patel and U. R. Patel, Anand.

The goradu soils of Gujarat were examined for a period of one year for the content of total nitrogen, nitrate nitrogen and soil pH..The crop grown was Bajari and Nitrogen was applied to the soil at the rate of 0 lb., 20 lbs.,30 lbs., and 50 lbs. of nitrogen per acre.

It has been found that the total nitrogen is practically unaffected throughout the period of growth of the crop. But after the harvest of the crop, the total soil nitrogen increases throughout the winter period and comes to a low level in summer. The nitrate nitrogen is high during hot months but falls during the rainy season, and continues at the low level throughout the whole of the monsoon and the early part of the winter.

The pH of the soil which remained about 8 throughout the period increases a little during the month of September.

20. Calcium and Oxalic Acid Content of Vegetables of Gujarat.

C. C. Shah and S. Z. Patel, Anand.

It is a well established fact that the presence of oxalic acid in a feed renders much of the calcium unassimilable. A number of vegetables are reported to be good sources of calcium, but in the absence of data regarding the oxalate content, this has little value in nutrition. For instance Fincke and Sherman found spinach useless as a source of calcium. Forty-five green foods including vegetables, leafy vegetables and tubers were analysed for the calcium and oxalate content. Of these five leafy vegetables and three tubers were found to have more oxalic acid than that necessary to combine with all the calcium. They are Amboi (Hibiscus sabdariffa), Luni; (Portulaca oleracea), Palak (Spinacea oleracea), Poi (Basella rubra), Onion leaves, (Allium cepa), Ginger, Turmeric, and Yam. Rich sources of available calcium are Curry leaves (Murraya Koenigii), Tandaljo (Amaranthus Gangeticus), Betel leaf (Piper betel), Cluster beans, (Cyaonoposis opsraliodes), Kankoda (Momordica Yoica) and Radish (Raphanus sativus) leaves.

21. Modification of Collin's Method for Determining Carbonate in Soils.

C. C. Shah and J. L. Amin, Anand.

A rapid method for the estimation of carbonate in soils has been described. Use is made of a solution of Trichloracetic acid (150 gm. acid plus 10 gm. water) to liberate the carbon dioxide. The volume of Carbon dioxide evolved from pure calcium carbonate is measured. An amount of soil equal to 100 divided by the volume of carbondioxide evolved from 0.100 gm. Calcium carbonate is taken for liberating carbondioxide. The volume of carbon dioxide then evolved divided by 10 gives directly the percentage of calcium carbonate in the soil. The apparatus used is also described and is simple to set up.

22. Colorimetric Determination of Soil Organic Matter.

C. C. Shah and B. V. Mehta, Anand.

A rapid method for determining the organic matter in soils with the help of Klett's Colorimeter is described. A weighed quantity of the soil is allowed to react with definite quantities of normal dichromate and concentrated sulphuric acid. The dichromate is reduced and a green colour is developed. The intensity of the green colour is proportional to the organic matter in the soil. The resulting colour is a mixture of green and yellow. It is found that the measurement of the green colour using a red filter is speedy and fairly accurate. There is no interference due to the colour of soil inorganic matter. It is not necessary to calibrate the mesurements with a standard soil by the dry oxidation method. The calibration can be done by stoichemical calcultion. The method is found accurate for soils containing less than 4.5% organic matter. For soils containing more organic matter half a gram of soil is recommended for analysis.

23. Studies on the Fixation of Phosphates in Indian Red and Laterite Soils: III: Fixation Studies by Shaking Method: Influence of Factors Involved in Shaking.

M. K. Mukherjee, Calcutta.

(Laboratory Studies Section, Soil Conservation Department,) Damodar Valley Corporation.

When fixation of phosphates is studied by following the shaking method, the influence of the variable factors namely:—

(*i*) The Soil: Solution Ratio ;

(*ii*) The concentration of phosphate solution ;

(*iii*) The period of shaking ;

(*iv*) The manner of shaking ; has been studied.

All influence the fixation and for this it is desirable, for comparative purposes that all these factors should be made constant. It is desirable in case of red and laterite soils that a high amount of phosphate say 2,500 p.p.m or even higher concentration at a soil: Solution ratio of 1.20 for a period of 24 hours is suitable and the amount fixed under these conditions would fairly indicate the fixation capacity of such soils.

24. Soils of Damodar Valley: I: Soils of Barhi Area.
A. Note on Preliminary Investigation Regarding Nutrient Status.

J. N. Chakraborty, M. K. Mukherjee and G. S. Roy, Calcutta.

In the Damodar Valley Project, the persons to be displaced for construction of Dams are to be rehabilitated. The soils of the area where displaced people are contemplated to be resettled are being surveyed to find out their suitability for agriculture. About 80 samples from Barhi Rehabilitation Area have been analysed for some plant nutrients. It has been found in majornty of soils that percentage Clay varies between 15-20%. These soils vary from slightly acidic to moderately acidic in reaction. Available P is very small, organic and difficultly available P are rather low and total Phosphorus is not inconsiderable. Exchangeable Ca is moderate and K is sufficient from the view point of plant nutrition.

25. Nitrogen Fixation and Seasonal Variation in the Nitrogen Content in Pusa Soil—under Cropped and Fallow Condition.

S. C. Datta and B. K. Das Gupta, New Delhi.

Nitrogen fixation and seasonal variation in the nitrogen content of Pusa Soil were studied for a period of about three years. Samples of both surface and sub soils from a plot measuring 1|24th acre were taken once in a month. One half of the plot was kept fallow and the other was sown with *Marawa* in *Kharif* and oats in *Rabi*. A portion of the sampled soil was kept at 30°C in an incubator at the optimum moisture content. Total nitrogen was determined after one month's and two months' incubation. It is found that nitrogen content of the soil reached its maximum twice in year once in August-September that is at the end of the rains and the other in March-April just at setting of he summer. The nitrogen content reached the minimum also twice a year, once during June-July when the rain fall was heavy and the other in December-January when the weather was very cold. It was also observed that the incubated samples of soil behaved in the similar manner as the field soil so far as the nitrogen content was concerned. The fallow plot always maintained higher nitrogen level than the cropped one ; but when the intake of nitrogen by crops was taken into consideration the level was found higher in the cropped plot.

26. 'Sterility' Disease of Pigeon Pea.

S. P. Capoor, Poona.

'Sterility' disease of pegeon pea (*Cajanus cajan Millsp.*) was reported from Bihar and simultaneously from Burma in 1931. It was brought to the notice of the writer in 1944, and became generally prevalent in the Bombay Province by 1946. A disease survey during that year revealed that 'sterility' was present in about 7 per cent of the crop. In January 1947, the disease had affected over 20 per cent of the plants grown for varietal selections at the Tobacco Breeding Station, Nadiad, North Gujrat. Investigations into the disease were immediately undertaken.

Diseased plants are characterised by a general palor, profuse and upright vegetative growth and absence of flowring branches. Leaves are generally smaller and pale green than normal, and often show a well marked mosaic pattern of pale green and light green areas. Malformation of leaf laminae does not occur.

'Sterility' disease was transmitted in 34 out of 75 plants grafted with diseased scion brought from Nadiad, while only in one of 22 plants inoculated by leaf rubbing in the glass-house at Poona. Grafted plants invariably showed mosaic symptoms in 35 to 40 days, but the plant infected by sap inoculation developed the disease after 81 days.

Symptoms of the disease, its behaviour under field conditions as well as in glass-house and the experimental evidence obtained are characteristic of a disease, and not consistent with a fungal or bacterial pathogen.

27. Relation of Food to ospore Production in *Phytophthora*.

M. K. Desai, Surat.

The heterothallic strains (+ and — or Tyagli and Nilekani) of *Phytophthora arecae* Coleman, which supposedly lost the capacity to form oospores, could be restored to their original capacity of copious production of oospores by passing them through live host tissue, i.e., by feeding them on their natural host or by culturing them on French-bean agar. A subculture of *Phytophthora* isolated from jack-fruit could be similarly induced to form abundant oospores. A subculture of *P. meadii* received from Delhi which had lost its power of forming oospores started forming them sparingly when grown on French-bean agar. Thus, there is no evidence to suggest that the loss of fertility is due to deterioration of one or the other sex. Trials go to show conclusively that the loss in ability to form oospores during the process of subculturing by a species of *Phytophthora* appears to be due to lack of favourable nutrition which if supplied restores the original capacity of forming ospores.

28. Breeding Rust Resistant Varieties of Wheat for Bombay Province.

V. P. Gokhale, B. B. Chowdhury, M. K. Patel and V. M. Chavan, Poona.

Stem rust of wheat (*Puccinia graminis tritici*) is the most serious disease of wheat in the Bombay Province. Breeding rust-resistant wheats is the only feasible and economic method of combating the disease. Work in this direction has been in progress since the year 1923. Earlier attempts aimed at introducing the blood to Khapli, the variety which was popularly considered resistant, into the commercial varieties of the Province. Two strains, viz. Bansiplli-808 (Jaya), suited for dry cultivation and Niphad 4, suited for irrigated cultivation were evolved in this manner. Though both of them withstood rust better than other varieties, they were not resistant in the real sense of the term.

Work based on the knowledge of the physiologic races of rust was started in 1941 when facilities for testing wheat varieties and hybrids under controlled conditions became available at Mahabaleshwar under an I. C. A. R. Scheme. None of the indigenous wheat varieties and only a few of the large number of exotic varieties tested so far proved resistant to all the races of stem rust known to occur in Peninsular India. The exotic rust-resistant varieties, being agronomically unsuitable for this province, were crossed with two improved wheat strains. Homozygous rust-resistant segregates possessing desirable agronomic characters have now been obtained from the following crosses:—(1) Kenya E. 144 X Niphad 4. (2) Hofed 1 x Niphad 4. (3) Mondhya 417-5 x Hofed 1.

These segregates are *vulgares*. The absence of a rust resistant *durum* wheat proved so far a serious handicap in breeding rust-resistant wheats to replace the highly susceptible *durum* varieties grown over a large area in this Province. Gaza, an exotic rust-resistant *durum* wheat is now available and has greatly simplified the task.

29. Control of Plant Diseases through Disease Resistance in Bombay.

M. K. Patel and M. N. Kamat, Poona.

It has been argued in certain quarters that field resistance is a sufficiently satisfactory basis for the isolation of resistant types of crop plants. This is really erroneous since experience with Pusa 4 and 12 wheats with reference to rust and Pusa 80 *tur* and Jarila cotton with reference to wilt has clearly shown the futility of such an argument. It is, thus, obvious that in any breeding programme for disease-resistance, there is a great need for approved technique whereby reliable and comparable results may be obtained at different times. Such standard techniques have been developed by Plant Pathology Section of the Bombay Department of Agriculture, pioneers in such a type of work in India, with reference to Fusarium wilts of sann hemp, *tur*, cotton, gram, lang, etc. The technique consists in the main, of testing and isolating resistant strains under standard conditions of soil temperature and infectivity in pots in a glass house and subsequent growing and selfing of the promising survivals in a highly infected plot. The process is repeated until homozygosity for wilt-resistance is attained.

Testing of wheat strains for stem rust-resistance is also being carried out at Mahableshwar by technique similar to the one evolved in U. S. A.. Several hybrids obtained by crossing Niphad 4 and Mondhya with Kenya E 144 and Hofed have shown homozygosity for rust-resistance and other desirable agronomic characters under field tests.

A technique, very similar in nature to the ones described above is being developed for testing rice plants against blast disease caused by*Piricularia orysae,* recently introduced into Bombay Province.

30. Bacterial Leaf-spot of Lucerne.

M. K. PATEL, Y. S. KULKARNI AND G. W. DHANDE, Poona.

A bacterial leaf-spot often mistaken for *Pseudopeziza medicaginis* was noticed for the first time in India in a *lucerne* plot on the Agricultural College Farm, Poona, in 1948. The pathogen was Isolated and studied in detail.

On leaves, the pathogen produces small, round, water-soaked spots measuring initially 0.5 to 1 mm. Some of the spots as they grow larger (1.5 to 2mm.) become irregular in shape having pale yellow centre with brown margins, presenting an appearance of an insect attack. When few such spots coalesce towards the tip and border of leaves, there occurs local distortion. Undeveloped spots remain as dark-brown specks. The pathogen produces small, brown, vertical scars on the stem.

The description of the organism as determined by us is given below:—Short rods measuring 1.96 μ x 0.80 μ motile by a polar flagellum, gram-negative, not acid-fast, non spore-former, staining readily with common dyes.

On potate dextrose agar plates, colonies are circular, smooth, shining, pulvinate with entire margins; colour baryta yellow (Ridgway); consistency butyrous; gelatin liquefied; starch attacked; litimus reduced; casein digested; nitrates not reduced; M. M. V. P. tests negative; ammonia produced; produces acid but no gas from arabinose, dextrose, lactose, maltose, and salicin; Loeffler's blood serum not liquefied; no growth in Uschinsky's solution; thermal death-point about 51°C.

Pathogenic to *Medicago sativa, Melilotus indica, Trigonella foenum-graecum* and *Pisum sativum.*

The organism is identical in morphological, cultural, physiological and pathological characters with *Xanthomonas alfalfae* (Riker, Jones and Davis) Dowson on alfalfa (*Medicago sativa*) reported from the U.S.A. and must have been introduced on imported seed from abroad.

31. Bacterial Blight Cowpea.

M. K. PATEL AND N. D. DIWAN, Poona.

A destructive bacterial blight of cowpea was first observed on the Agricultural College Farm, Poona, in May, 1945. The disease appears as light yellow, irregular to round spots, measuring 4-10 mm., with necrotic brown centres. These spots increase irregularly until the entire leaf is involved. The dark, yellow colour surrounding the central pale brown spot fades off at the periphery while the small veins within the spots become reddish brown and shrivelled. This discolouration of the veins may extend beyond the margin of the spot. In some cases, infection follows the veins, and the area around the vein becomes yellow. Heavily infected leaves become straw-coloured and remain hanging but drop down at the slightest touch. In severe cases of blight, the leaves dry up without showing any spots. In nature, infection takes place through stomata. No infection occurs on petioles and stems except through wounds. On the pods, the infection occurs in the form of dark green, water-soaked spots, 1½ to 2 mm. in size and varying in shape and number. Infection does not seem to extend to the seeds.

The morphological, cultural, biochemical and pathological characteristics of this organism resemble those of *Xanthomonas vignicola* Burkholder except in few minor details. The pathogene infects *Vigna catjang, V. sinensis, V. sesquipedalis* and several varieties of *Phaseolus vulgaris*. This is considered to be another instance where the pathogene has been imported from abroad.

32. Bacterial Leaf-spot of Chillies.

M. K. PATEL, Y. S. EULKARNI AND G. W. DHANDE, Poona.

A bacterial leaf spot of chillies (*Capsicum frutescens*) was noticed for the first time in India on chillie leaves on the Agricultural College Farm, Poona, in August 1948.

On leaves, the pathogen produces initially a number of small spots which as they develop, become round to irregularly round (1 mm.) with raised water-soaked borders on the lower surface and a pale white centre with a slight depression on the upper surface. Leaves appear curly when edges and veins are infected. A few spots coalesce to form irregular lesions. The raised water-soaked borders of old spots become brown on both the surfaces. Severely affected leaves become yellow and drop off prematurely. Infection of leaf-petiole is common. When the pathogen infects tender stems, it produces longitudinal light brown cracks measuring sometimes 4 cms. In severe cases, wilting of young plants occurs due to girdling of the stem by the organism. The first visible symptoms on the fruit is a raised water-soaked spot which becomes brown with a depression in the centre.

Xanthomonas vesicatorium (Doidge) Dowson Short rod, gram-negative, motile by a polar flagellum, not acid-fast and measures 1.7 μ x 0.9 μ

On potato dextrose agar plates, colonies smooth, glistening, raised, diam. 1 to 1.2 cm. in 4 days, colour apricot yellow (Ridgway); On nutrient agar plates, colonies flat, smooth, glistening, round with fringed margins, diameter 1 cm. in 4 days, the inner 9 mm. of the colony lemon-chrome (Ridgway) while the outer 1 mm. periphery of the colony is pale white; slight clearing of milk in 4 days; litmus reduced; gelatin liquefied; starch attacked; produces acid but no gas from dextrose, lactose, sucrose and salicin; nitrates not reduced; ammonia produced; Loeffler's blood serium slowly liquefied; M. R. V. P. tests negative; thermal deathpoint abount 51°C.

The disease is seed-borne; pathogenic to *Capsicum frutescens* and unripe tomato fruits.

33. Control of Yellow-Vein Mosaic of Bhendi in Bombay Province.

P. M. VARMA, S. P. CAPOOR and M. K. PATEL, Poona.

Bhendi (*Hibiscus esculentus*, L.) is a very important vegetable crop and is grown all over the Bombay Province throughout the year. During summer (March to June, however, it is cultivated only where fecilities for irrigation are availble.

The bhendi crop is seriously affected by a virus disease designated as *Yellow-Vein mosaic* on account of the characteristic yellow vein symptoms produced on the leaves.

As a result of infection, both the quality and quantity of fruits are considerably reduced. The virus is neither sap transmissible, nor does it pass through the seed but is readily transmitted by grafting. The white-fly *Bemisia tabaci* Gen. is the only insect vector.

The diseased plants left in the fields after harvest act as the chief source of infection for the new crop. Again if the few diseased plants that are present in the beginning if removed from a field, the disease spreads rapidly and within a month a major portion of the crop is affected.

Experiments carried out within a radius of three miles with the College of Agriculture, Poona, as the centre have shown that the disease can be effectively controlled if :—

(*a*) all bhendi plants during April and May are destroyed,

(*b*) a close season of two months during June and July is observed when no bhendi crop is grown and

(*c*) the newly sown crop is rogued at weekly intervals and all the diseased plants destroyed.

Rogueing the diseased plants at regular intervals had kept the disease within four percent, whereas in the unroguued plots it went up to 73 percent in 2½ months. The yield was similarly affected.

34. Preliminary Studies on Wing Development in Aphids.

H. L. KULKARNY, Poona.

(1) An account is given of the results of a number experiments concerning the influence of certain factors on wing development in aphids with reference to *Macrosiphum jaceae.*

(2) Result of a number of laboratory findings shows that overcrowding on the host plant alone did not induce wing development in *M. jaceae.* The laboratory findings were in support of the field observations.

(3) The period of artificial darkness ranging from 1-5 hours per day was not favourable for wing development in *M. jaceae.* It was further observed that the aphids did not reproduce normally under dark conditions and they suffered in growth.

(4) The aphids produced from alate or apterous mothers of *M. jaceae.* and reared up to three generations did not show wing development in any of the generations.

(5) Statistical analysis has revealed that temperature rather than any of the other factors tested in the experiments, such as period of darkness, over crowding or humidity is very highly correlated with wing development in *M. jaceae.* It has shown further that if there are several factors causing wing development in aphids, as may well there be, the two factors—temperature and humidity—which invariably go together, particularly temperature, are the most important of them all for promoting wing development in *M. jaceae.*

35. The Measurement of Linkage Between Characters Determined by Dissmilar Factors with Complete Dominance.

N. R. BHAT, Poona.

Alam (1929) developed formulae for the calculation of linkage between characters either or both of which were governed by two or more complimentary and or duplicate factors. He has given empirical methods of arriving at them in other similar situations.

However, the methods suggested by him are not found to be applicable to cases wherein the characters are determined by two or more dissimilar factors.

In the present paper suggestions are given, for such cases, in respect of:—

(*i*) the method to be adopted for the detection of linkage or independence,

(*ii*) the method of deriving the expectations in terms of the recombination fraction, and

(*iii*) the procedure to be adopted for obtaining the most accurate information from the data when there are more than 4 phenotypic classes in the joint segregation.

The suggestions made are illustrated with examples.

36. Land Erosion and its Control.

U. S. MADAN, Virmani.

Erosion is a combination of weathering and denudation processes and is the washing away and carrying of soil particles by water or wind or both.

Causes of erosion are fire, overgrazing, overfelling and bad cultivation.

Two types of erosion-wind and water latter is of serious danger. Sheet and Gully erosions are further types of water erosion. Hundreds of torrents emerge from denuded hills as the effect of erosion. Adverse effects of erosion are:—

(1) Increase in the intensity and frequency of floods.
(2) Decrease of dry weather flow in rivers.
(3) Silt increase in rivers.
(4) Reduction in cultivation area.
(5) Fall in water level.
(6) Silting of irrigation and hydro-electric works.

Control comprises of passive and active measures. Passive are closure to grazing and browsing and educating the masses. Active measures are by afforestation of denuded hills, digging of contour trenching, gully plugging, canalising and having shelter belts on both banks of the chos and by terracing sloping fields.

Land Erosion: Control of erosion by Nature will prove ineffective unless human activities contributing to erosion are given up. The land has its limitations, and though its yield may be scientifically increased, the over-worked land is bound to go into decay. A symbiotic relationship, taking as well as giving, is essential between man and land. From the agricultural standpoint, erosion occurs through rain, rivers, frost, wind, and sun. Cover of land by vegetation is the main single protective measure, involving creation of forest belts and growing of detached trees. Terracing, stripcropping, and contour-ridging are essential. River erosion can be countered by strengthening river banks with soil-binding plants. Floods can be checked by diverting flood-water into escape channels, from which it can be gradually drained off. Over-grazing needs to be stopped, and the livestock reduced in number. Other sources of food, not dependent on land, should be exploited, specially river fish. Fish is destroyed in large numbers by sewage and industrial wastes discharged into rivers. Manure contents could be extracted from sewage and profitable by-products recovered from industrial wastes.

L. S. S. Kumar, Poona.

Camphor basil (*Ocimum kilimancharicum*) is richer in camphor compared to other basils. Seed obtained from Africa was treated with colchicine to study the effect of polyploidization on the camphor content. The untreated plant has a 2n complement of 64 to 72 chromosomes. Pairing is mostly into 32 bivalents, with occasionally 4 to 6 quadrivalents. Maximum secondary association is into 8 groups and it is an Octoploid ($x = 8$). Since pairing is mostly into bivalents the species has an amphidiploid origin.

Plants treated with 0.9% colchicine solution in water were affected. Three plants examined had 128-140 chromosomes, characteristic of a 16-ploid. Maximum secondary association in the higher polyploid was nearly into 8 groups.

The camphor content of the normal and higher polyploid were determined by colorometric method. The results indicated that there was either an approximately the same or a slight reduction in camphor content. The slightly less camphor content is offset by the considerable vegetative vigour which may ultimately give a higher camphor content per acre, for determining which yield trials would be undertaken. Seed setting in the higher polyploid was considerably less than in the normal.

Cytological studies of the different species of *Ocimum* and their synthetic polyploids are in progress to determine the optimum chromosome number associated with maximum camphor content.

38. A Preliminary note of the Selective Transference of the Individual Chromosomes of *Gossypium Anomalum* to *Hirsutum* Cottons.

G. B. Deodikar, Poona.

The synthetic hexaploid (AA DD BB), [(hirasutum AADD x *anomalum* BB) Doubled], is being repeatedly backcrossed to *hirsutum* for transferring to it the superior fibre qualities of *anomalum* and its immunity against the *Bacterium malvacearum* causing angular leaf spot or blackarm disease in cotton.

Observations on the B1 and the reciprocal B2 populations indicate the possibility of (1) exchange of genes between A and D sets through the bridging influence of the B genome (2) Transference of *anomalum* genes to A and D sets by their partial homologues from B genome (3) substitution of chromosomes from A and D sets by their partial homologues from the B genome. (4) addition of *anomalum* chromosomes to the *hirsutum* (AADD) complement.

Some of these expectations have been partly realised in the B2 raised from (hirsutum x B1). Differential performance of the two reciprocal B2 populations indicate that the female gametes of B1 individuals show a greater disposition for transmitting the chromosomal abnormalities as compared to the male gametes of the same individuals. It also indicates the mutual compatibility of gametes which are genomically balanced or have a near approach to that condition.

39. Studies on the Comparative Anatomy and Physiology of Two Wild *Oryza*.

G. V. Chalam, Cuttack.

The rate of transpiration in *Oryza fatua* is found to be three to four times higher than that in *Orysa coarctata*.. This difference is associated with structure of epidermis and stomata in both the species. *O.fatua* has larger and broader leaves with serrate margin, while *O.coarctata* has narrow leaves with spinose margin. The latter is characterised by ridges and grooves in the inner surface and smooth outer surface, absence of midrib, larger epidermal cells with thick radial walls at the margins. Trichomes on the ridges arch over the groove and protect the motor cells. Stomata are present only on one face while in *O.fatua* stomata are present on both the surfaces and the number on upper surface is larger. Lignified cells are present in the upper part of the ridge while those are absent in *O.fatua*. In *O.coarctata* there are three on four layers of sclerotic cells below the upper or lower epidermis which are not so prominent in *O.fatua*. In *O.coarctata* number of primary veins is larger. The leaves are not easily susceptible to desiccation and leaf rolls longer than that in *O.fatua*. At the basal portion there is considerable air space between motor tissue and lower epidermis, while in *O.fatua* instead of air the space is filled up with mesophyll. The leaf margins are thinner than the blade in *O.coarctata*. The motor tissue is situated at a lesser distance from the margin in *O.coarctata*, consequently it was observed that the rolling of leaf commences from the margin. *O.coarctata* has characters of a sclerophyllous plant.

Loss of water is very rapid in case of *O.fatua* while the same is very slow in *O.coarctata*. In the first thirty minutes 21.3% is lost in *O.fatua* while 10.85% is lost in *O.coarctata;* when the static condition is reached by both the former has lost 72.4% while the latter has lost 24.2%.

SECTION OF PSYCHOLOGY AND EDUCATIONAL SCIENCE

PRESIDENT—Prof. Kali Prosad, M.A. Ph.D.

A.—GENERAL PSYCHOLOGY

1. "Functional Autonomy".

DAMODAR MISRA, Orissa.

Psycho-dynamics has progressed rapidly in the last few years in the history of Psychology as a Science and conflcting theories of motivation have since been reconciled and have boiled down to one systematic theoretical position in the various fields of psychological investigation on the problem of motivation animal and human.

This essay has been essentially an endeavour to show the theoretical importance of the concept of "Functional Autonomy" in the final systematisation of the theory of motivation. Besides the pre-potent biological drives of the behaving organism acquired action-tendencies do also acquire a strong driving force as a variable intervening between the stimulus and the reaction. This trend of thought in building a systematic theory of motivation originated in 1918 in Woodworth's extramural lectures wich he delivered at Columbia and which later he published in the shape of a book entitled Dynamic Psychology'. "Mechanisms may become drives" was the fundamental theme which he developed and this descriptive sentence later developed into the more appropriate concept of "Functional Autonomy" in the hands of G. W. Allport. Further in what is now described in experimental literature as 'instrumental learning' the same conception is demonstrated. The instrumental character of a behaviour item acquires a driving force as strong as a pre-potent biological drive through continued repitition and reinforcement. With this the distinction between pre-potent biological drive and an acquired habit becomes one of quality and origin and the age-old behalf that a biological drive is stronger than any intellectual, social or cultural one falls to the ground. Man's acquired cultural and social needs may, in fact, be stronger at times than the pre-potent biological needs.

2. Problems and Methods in the Psychology of Personality.

H. S. ASTHANA, Lucknow.

The paper critically examines various problems that have been raised and the methods that have been employed for their solution in the Psychology of Personality. Physiological, behaviouristic, psychoanalytical and psychometric approaches haveen examined. The Gestalt and Topological theories have been examined and the contribution of the cultural and social science theories evaluated. The paper finally attempts to show that some type of physico-cultural field which need not necessarily be non-metricised provides the most satisfactory framework for studying personality dynamics.

3. Indian Typological Theories of Personality.

H. S. ASTHANA, Lucknow.

The paper attempts to analyse the different types of personalities which may be discovered in ancient Indian Psychology. A study of the types of Personality is undertaken in (*i*) the phsiogonomic and astrological literature, (*ii*) in the philosophico-psychological theories of Samkhya and Buddhism, (*iii*) in the field of Sanskrit literature (*iv*) and in the psycho-sexual and psycho-medical theories. The types are compared and evaluated in the light on the western typology. It is observed that many of the Indian theories provide a very rich variety of personality types. It is further shown that the Indian theories raise some very pertinent problems which must be accounted for by any theory (ancient or modern) of personality.

4. Response Psychology and Interpretation of Dreams.

SRIMANT LAL DAS, Patna.

Response Psychology has its Response Theory of Dreams. A large number of our dreams are clear cases of direct response of the inner world. Freud's wish-fulfilment is but one aspect of the more comprehensive response theory. Compensation, not wish-fulfilment, gives the correct theory of dream.

From the practical point of view, dreams may be divided into the significant and the insignificant (meaningless) dream.

The language of dreams being preeminently symbolical, key to the interpretation of dreams is to be found in the full meaning for the individual of the symbols seen in dreams.

Dreams are of vital importance to a religious soul, seeking hints, light and guidance from God. "The dreams of a prophet" says Muhammad, "are not dreams, but revelations."

Response psychology is especially interested in 'prophetic dreams' often transcending all logical calculations, predicting the future, and transforming one's character out of recognition.

The author has given an account of three prophetic dreams of his life and their interpretation.

The paper concludes with an interesting explanation of how a tiger in dream has become a symbol for Sri Krishna for the author.

5. Dream

UDAI BHANU, Indore.

The subject of dream is very interesting. From time immemorial learned persons have been studying it but the problem has remained still unsolved. This paper is an attempt in that direction.

The following conclusions are drawn from my study:—

I. Dream is the spontaneous reproduction mostly of visual forms during sleep. Sensations other than visual are hardly reproduced.

II. Colors are rarely seen.

III. Between the presentation of a stimulus and its reproduction in dream, there is the period of inactivity. It can best be called latent period. It varies considerably from man to man.

IV. The capacity to reproduce things is weakned by its activity.

V. There is no correlation between the order of presentation and that of reproduction. We never dream things in the order of presentation.

VI. Emotion and associative system reduce the latent period.

VII. Weak sensations require some period of inactivity for reproduction after stimulation.

6. Effect of Mental Set and Shift.

K. C. Mukherjee & Ajit Roy, Calcutta.

The fact of mental Set is primary in all conscious activity. Widely different response-patterns depend upon the mental Set and adjustment.

If a person is asked suddenly to stop his work in which he is engaged and is immediately asked to under-take a new work which is quite opposite in nature, he is, then to adjust himself in another way for the successful performance of this work; he is to give up his previous attitude and to adjust himself in a way, which will help him in the new work. But this adjustment requires time and practice; because the previous tendency begins to persist when another nature of work comes suddenly. So the time required for the second work will be greater than the first.

Conclusion: We have observed from a large number of cases that the shift effect is great in the case of the attentive work. This effect is greater specially in the case of the School Students than the College and the University Students. This may be due to the fact that the college and the University Students are highly intelligent and much more mature than the School Students.

B.—SOCIAL PSYCHOLOGY

7. Honesty Index—a further note.

S. N. Sastry, Bangalore.

One hundred students took the two honesty tests. The suggested index of honesty *i.e.,* H.I.—s|n x r|x.

(Where s is the total score a testee gets, n is the number of cases, r is the number of successful performances and x is the number of erucial cases) was applied and the honesty value was determined for the reaction of the subjects. The subjects were given the analogies test. They were asked to indicate on a given scale of 10 units. the position of the answer in regard to their honesty value. These are compared with the former honesty-rating and the performance in the intelligence test.

8. Security Index

N. S. N. Sastry, S. K. Ramachandra Rao, and M. C. Satyanarayana, Bangalore.

An attempt is made to study the sense of security prevailing in the middle class educated unmarried males between the ages of 20 to 25 years in Bangalore City by means of a small sample survey as a preliminary and the data so obtained is statistically analysed. It is found that the security index is normally distributed and is a linear function of factors affecting the security of an individual to a fair degree of approximation. The dominant factors which contribute to a feeling of security in a person are social, economic and personal factors in the order of their importance.

9. Role of Values in Social Relations

N. S. N. Sastry and S. K. Ramachandra Rao, Bangalore

Socialisation of the individual takes place early enough in order to enable the individual for successful social adaptation. The process gives rise to an appreciation of values which become integrated in the personality of the individual. The paper records a survey and measurement of the ideal and actual values that are thus responsible partly for the evolution of the personality. About one hundred persons took the test in which they were expected to indicate their expectation of qualities in the persons immediately in the surrounding environment. They were also told to indicate the actual results of those qualities. A comparison of these two based on statistical manipulation of the dta shows that the values have an important function to fulfill in determining social relations.

10. Measurement of attitudes in social relations

N. S. N. SASTRY and S. K. RAMACHANDRA RAO, Bangalore.

The paper is an attempt at measuring attitudes that are developed specially in relation to social factors. The personality values with reference to different individuals in the immediate social environment like father, mother, brother, sister, friend, husband, wife are the subject of the study and evaluation. The topological interpretation based on Lewin's method with certain modifications has been employed. The ideal and actual values making up an attitude with reference to the several persons in the social environment are analysed and it is shown that definite interactionism between social factors and the personality factor results in the development of the attitudes which are evaluated in the paper.

11. An Enquiry into the Drug Habit with Special Rerefence to Smoking.

C. BHEEMASENA RAO, Bangalore.

The paper records an enquiry into the habit of smoking, the origin of the habit, the retention and intensity and its psycho-social significance. Eighty persons took the test which was in the form of a questionnaire to be answered. The questionaire covered all the different aspect of the enquiry. The importance of the psychological factors is brought out clearly The intensity of the drug habit, ethical considerations thereof, the contribution of environmental factors are estimated on the basis of the frequency of factors as indicated in the answers to questions. This pilot survey can be usefully modified and applied over a wide area in order to elicit the proper solution to the problem already stated.

C.—EDUCATIONAL PSYCHOLOGY AND TESTS

12. Objective Tests and their place in University Education.

J. M. SEN, Calcutta.

It has often been sated that so far as the present system of examinations in the University or Board of Secondary Education is concerned the judgments and opinions of individual examiners are variable factors in human life. And unless methods are devised for controlling the variations in the opinions and judgments of each examiner there cannot be any improvement in the examination of candidates for the various types of examinations conducted by the different authorities. Therefore, as a logical corollary, abolition of examinations is urged. Should they be abolished altogether? Or, should they be remodelled on an objective basis? These are our present problems. Associated with these problems is the eternal question—what can the teachers do to improve the present situation? Can they help in controlling the variability of the factors, enumerated above? The paper discusses in detail the problems and the factors involved in conducting an examination and establishes the proposition that because of the importance of having an examination programme which gives evidence of the degree to which students are reaching each of the significant objectives of the subject an essential step in planning an examination programme is to formulate in a clear and understandable fashion the important objectives which instructor is trying to reach.

13. Distribution of Mechanical Ability among Engineering Students

S. P. SRIVASTAVA & ABDUL HAMSED.

The paper reports the conclusions of a series of investigation on the distribution of mechanical ability among civil, mechanical and electrical engineering students in the Technical schools of Lucknow. The M for civil engineering 1st & 2nd year students were respectively 34.9 and 38.2 and the S. D. for the same 9.8 & 9.2. (When the respective N were 51 and 43 representing 50% sample). Similarly the M of the 1st, 2nd & 3rd year students of mechanical & electrical engineering classes were respectively 38.7, 42.3 & 37.7; the S.D. for the same being 8.6; 10.5 and 9.1. (When the respective N were 30, 32 & 28 representing total population).

The test given to the students was the "Revised Minnesota Paper Form Board Test, series AA.

14. Hindustani Adaptation of the Pressey X—O Test of Emotion for University Students.

MISS. BIMLA, Lucknow.

The paper reports the results of the preliminary investigations on the adaptation of the Pressey Cross out Test of Emotion (revised by M. Collins) for Indian Students. The test has been considerably modified in view of the different Socio—Cultural conditions obtaining in this country. The affectivity scores range from 22 to 121. The paper gives the table of norm for Idiosyncrasies.

15. Place of Temperament and Disposition in Social Adjustment:

JNANENDRA DAS GUPTA, Calcutta.

The paper attempts to show by a compartive study of two cases the place temperament and disposition occupies in the adaptation of a person to his or her fellow-beings. The cases referred to are those of two girls who are near each other in intelligence as well as in age. The girls are seventeen and sixteen years of age and their I Q.2|5 are 75 and 65 respectively. Their scholastic success or to put it more accurately, failure show again striking similarity—The older girl had to stop her scholastic career at Class VII, while the younger girl stopped at Class VI. They however widely differ from each other in their achieved social success. While the younger girl may, with good reasons, be regarded to have succeeded in the social sphere, the older girl has failed. We have been able to undrstand that success of one and failure of the other in social adjustment is due to important temperamental and dispositional differences found in them.

The personality traits which helped the younger girl to make social-adjustment may be mentioned as following:

(1) Confidence in people,
(2) Confidence in herself,
(3) Surgency of temperament,
(4) Ability to understand others and
(5) Power of easy submission.

The older girl lacked almost all of these temperamental traits. In our two cases, we have found for social power of sumbission as the most important. At least, it is certain that the power of easy submission is one important cause in helping a wholesome social adjustment; when, however, the power of easy submission is absent, it acts as the most important cause in hampering a good social adjustment.

16. Word Frequency in the Bengali Language and A Word Book for Readers.

K. D. GHOSH, Calcutta.

This is a study of word frequency in the Benegali Language with a view to the preparation of a Word Book of about 1500 commonest words for use in Children's Readers and Adult Education Books. The list has been made up of 1000 commonest words in the Bengali Language selected both on the ground of range and frequency out of a word count of over 2 lakhs of words and about 450 words used by adult illiterates in their daily living of life.

17. Attitude to Supervision,

L. J. BHATT, Baroda.

The Teacher and the supervisor contribute to the achievement of two difinite purposes, namely, the acquisition and development of skill on the part of the teacher and evaluating supervision,—a set of four questions were put to a batch of B.T. students to determine the helpful things that were done by the supervisor, things which were done and were not useful, help which a teacher needed most and was not given, the way in which supervision proved deterimental.—Analysis of answers—Another quiz wherein answers expected were in 'yes' or 'No' form to determine the attitude of teachers to supervision;—Discussion of answers;—phrases and expressions used by the batch arranged on a sheet and the batch asked "to cross out" the undesirable items, etc.,—discussion of results. Summary and Conclusions.

D—INDUSTRIAL PSYCHOLOGY

18. Group differences in manual dexterity among Children attenting ordinary school and the technical school.

DEVENDRANATH L. AMIN, Mysore.

The paper reports the data and the conclusions obtained from five tests of manual performances administered to two groups of children having the same mean chronological age (15 to 16 years). The number of students attending routine types of technical courses is 123 and the number of students attending ordinary school is 128.

The analysis suggests that that tests involving finger dexterity show significant difference between the technical and non-technical students, while in other tests the difference is not significant though favourable to the technical students except in the threading test.

19. An analysis is of the effectiveness of the financial incentives adopted to reduce absenteeism in a cotton textile mill.

DEVENDRANATH L. AMIN, Mysore.

The paper reports the monthly variations in absenteeism, the effects of absenteeism on production, the causes of absenteeism, and the financial incentives that are provided to check the rising percentage of absenteeism. Futler, the data is anlysed to determine the effectiveness of the measures adopted and better incentive method is proposed.

The data covers an experimental period of four years in a contton textile mill.

20. Fatigue and Efficiency in Textile Industries Report of work in the Weaving Section.

KALI PRASAD and KAMLA KANT, Lucknow.

The enquiry on Fatigue and Efficiency in Textile Industries started in July 1947 in the spinning section in the Swadeshi Cotton Mills at Kanpur was extended to the weaving section. Some of the preliminary findings are: Gradual rise in output from the first day of the week to the last except for Friday when it falls down and approximates to Tuesday level, maximum production in the months of November, December and January; unlike other shifts no marked improvement in performance after the rest interval in the night shift; increased output for the last hour of the shifts constitutes another peculiarity of the weaving section. The investigation is still in progress.

21. Enquiry on Fatigue and Efficiency in Textile Industries. Report of work in Spinning Section.

KALI PRASAD, H. S. DAVE and KANT, Lucknow.

The investigation in the spinning section was continued and the earlier methods of studying fatigue were improved upon. 'Relative Efficiency Ratio' and 'Criterial levels' were devised measures of output to serve as indices of Fatigue.

E.—EDUCATIONAL STATISTICS

22. Literacy Estimate for 1949.

P. D. SHUKLA, New Delhi.

Detailed figures of literacy percentage in India were worked out in the year 1931. In 1941 Census, however, such detailed investigations could not be made; but fairly exact figures of the literacy percentage in the country could be worked out from a Press Communique which was subsequently issued by the Ministry of Home Affairs (then Home Department), Government of India. The present note attempts to analyse rise in literacy during the last few years and aims at working out an estimate of the literacy percentage as it exists in the year 1949.

23. Educational Interests of Students of Philosophy.

RAM MURTI LOOMBA, Lucknow.

The paper presents the results of an investigation into the interests of stduents of Philosophy at the Lucknow University—(*a*) in the Subjects taught at the University in the Faculty of Arts, and (*b*) in the courses offered for instruction in the Department of Philosophy.

24. "Certain Aspects of work Curves.

R. RATH, Calcutta.

Work curves appear to be periodic and this periodicity can be explained as geometric. Such geometric ratios are few in number. The phase is constant. There are no oberservable indivisual differences either in the tasks involved or person working *i.e.* the curves for different tasks and produced by different persons at different times and places do resemble in their trough and crest placings.

The hypothesis is that there is a pool of all possible waves of general purpose mechanisms emergence of which is chance determined. An individual curve takes only a random handful of them. But in the long run all the waves will have a chance to appear. That is the reason why grand total curves resemble one another where as individual curves differ widely. In other words the larger the number of individual curves combined in grand total curves, the greater is the approach tc a standard form or outline.

This has been demonstrated by different statistical methods such as smoothing, shaping, analysis of variance and cerrelation of curves.

F.—PSYCHOLOGY OF MUSIC AND EDUCATION

25. Psychology of the Drone in Melodic Music

B. Chaitanya Deva, Poona.

One of the basic principles of artistic technique in music is the resolution of excitation into repose. In melodio music this is achieved by the resolution of dissonance into consonace and the movement of the melody away from the base of rest into a movement towards the base. The function of the drone (as supplied by the *tambura*) is discussed from such a point of view. (1) The *tambura* suplies the tonal background necessary for the proper perception of the consonance and dissonance of the various tones in a melody. Such a background is seen to consist of (*a*) the objective overtones generated by the strings of the *tambura* and (*b*) the subjective tones—aural harmonics and combination tones—produced within the ear. The factors considered in this context are: the probable number and intensity of these tones, the effect of phase differences among them, and their mutual masking. The more prominent combination tones from the G and F types of drones are given. (2) The position and significance of the drone in a melodic movement is discussed under two heads: (*a*) as an integrator, when the drone functions as an auxilliary to a psychological base in relation to which all the notes in the melody are perceived. This psychological base, with the extenal drone as a help, integrates the melody into a whole. A probable auditory and psychological mechanism for the process is suggested (*b*) as a rest note into which the whole melody finally comes to rest. Any movement away from this creates an excitation which is eventually resolvedy by coming to rest on this note. The nature of subsidiary tonics and leading notes are discussed. In this case also, the phenomenon is primarily psychological and the drone is a subsidiary.

G.—INDIAN PSYCHOLOGY

26. Psychology and Education.

Hareram Hajrah, Asansol.

Psychology, being the Science of the mond', lies at the root of all educational theories, which are but means to some nobler end,—the right growth of a budding mind. Hence, the study of Educational Psychology calls for special attention of the educationists and all teachers, who are entrusted with the sacred charge of moulding our future hopes, through the crucible of such wise systems of education, as are requisitioned by our present needs. Guardians of young learners might be equally benefittel by the first-hand knowledge of the Psychological processes in elucation, in dealing with their less gifted wards, who are often a contant source of trouble and ansuety to them. The study of the unconscious self, expounded by the Freudian school, in particular, throws a flood of light on all the dark problems regarding the unsocial activities of the abnormals. The writer, in this article, has ably dwelt upon all such subtle questions, which may be interesting to the men of the education world.

27. "Critical Concept of Dreams in Aurveda".

K. C. Mukherjee and Sarat Roy, Calcutta.

(1) This paper deals with the theory of dreams as represented in Ayurveda. There are five types of dreams:—

(*i*) *"Anubhutas"—i.e.,* dreams of those objects which have been seen, heard or felt, this one is reproduced by past experiences.

(*ii*) *"Prarthitha"—i.e.,* dreame of those objects which are desired or the effects of fulfilled desire.

(*iii*) *"Kalpita"—i.e.,* dreams by constructive imagination.

(*iv*) *"Dosaja"—i.e.,* dreams due to Pathological or morbid conditions.

(*v*) *"Baibhutika"—i.e.,* dreams that are premonitery of future event or prophetic dreams.

(2) Among these "PRARTHITA" and "KALPITA" dreams are nothing but "Repressed—"VASANA" (wish) of "SAGUNA-ATMA". This "VASANAS" of "ATMA" are usually repressed or suppressed by "BUDDHI" and "AHANKAR" as the case may be, which are enlightened by education, social enviornment as the person grows up. Here we find same similarity to the Freud's theory of Dreams. "BAIBHUTIKA or Prophetic dreams have some similarity to the dreams as advocated by Adler.

(3) Dreams some times manifested by "SANSKARA" and this lies in our unconscious rather in a dormant stage of mind; and this one is inherited by the son. "ATMAJA"—means Son—Son inherits this from parents. Here we find, some similarity with the theory of "Collective-unconsciousness' propounded by Jung and which is an influencing factor for guiding future life of boy. This also comes under the group of "MAIBHUTIKA" dreams!

(4) "TAMASIKA-SLESHMA", envelops the "MANAS" and thereby disconnects the chain between Manas and other "Indriyas" (Sense-organs) and causes sleep. During sleep at the "SWAPNA" stage (dream stage) these "VASANAS", the repressed wishes of the "ATMA" reflects on its and with the help of the "MANAS" the "ATMA" fulfils its wish or desire through this dreams and thus gets "ANNANDAM". In this stage the "MANA" becomes of another personality. During waking time when this "TAMASIKA"—SLESHMA" wane away the "MANA" forgets all the events of the past night. If this "TAMASIKA-SLESHMA" does not wane away, the personality which was playing a different role get fastened on it and the man becomes a different man of personality during waking time, and and these cause abnormality as we find in "APASMARA", Hysteria, Soldier-neurotic, etc.

28. The Place of Emotions in Yoga.

Parmanand Misra, Lucknow.

The paper discusses the place of Emotion in Patanjal Yoga. In Yoga Psychology emotions are specific differentiations of the constellations of the residual impressions (samskara-punja or Vasana-punja) embedded in the very structure of mind (vipakanugunah vasanah tah chitta bhuman asherata iti ashayah-T. V. 1-12). In other words, emotions are desires (asmita) analysable into attachment and aversion (raga and dvesha) having their respective parinama as pleasure and pain (sukha & dukha) respectively (sukhanushayi ragah: dukhanushayi dveshah-Y. S. 2-7, 8). Emotion, "begins in and looks back to, a feeling of positive Pleasure or Pain, and looks forward to and ends in, in possible Pleasure or Pain". The mind is to be rid of all the agreeable or disagreeable emotional distractions and attendent tensions (Y.S. 1-31) in the processes of ekatatvabhyasah (Y.S. 1-32) and vairagya (Y.S. 1-15). The physiological emotional changes are of course, observable in Asana (Y.S. 2-46) and Pranayama (Y.S. 2-49) two of the Ashtangas (Y.S. 2-29).

SECTION OF PHYSIOLOGY

PRESIDENT: SHRI KALIDAS MITRA, M.B., D.P.H., D.T.M. & H., F.N.I.

Pharmacology

1. Effect of Sodium-acetate on Pancreatic Digestive Enzymes.

M. C. NATH AND V. G. HATWALNE, Nagpur.

Influence of sodium acetoacetate on pancreatic digestive enzymes were studied and the following observations were recorded: (*a*) Pancreatic amylase is slightly inhibited by Na acetoacetate, (*b*) Pancreatic lipase is also slightly inhibited by Na acetoacetate, (*c*) Pancreatic amylase is inhibited to a greater extent than the pancreatic lipase by Na acetoacetate, and (*d*) Proteolytic activity of pancreatin is not affected by Na acetoacetate.

2. Studies on Experimental Diabetes.—Part II.

Effect of acetoacetate on the lactic acid and vitamin C content of the blood in rabbits, and the additional influence of amellin and insulin.

M. C. NATH AND C. H. CHAKRABARTI, Nagpur.

Sodium salt of acetoacetic acid when injected into the normal animals (rabbits) in increasing doses beginning from 50 mg per kg. body weight, increases blood lactic acid enormously. After 90 days of such injection, the average value of blood lactic acid rises to 92 mg from the observed average value 12 mg per 100 c.c. of blood.

Plasma ascorbic acid is reduced to 1.10 mg from 2.72 mg per 100 c.c. after 40 days of such injection in another set of animals receiving about half the dose of acetoacetate.

Administration of amellin (injection), prevents the accumulation of lactic acid in the blood of the animals receiving sodium acetoacetate injection for 90 days and brings the value to the normal limit within 40 days.

Insulin, on the other hand, is not found so effective when injected in another set of treated animals for 40 days. The blood lactic acid diminishes initially but rises again in spite of continuation of insulin injection along sodium acetoacetate.

Amellin treated animals showed better state of health than insulin treated ones.

3. Studies on Experimental Diabetes.—Part III.

Effect of sodium acetoacetate in increasing such other constituents of blood as are high in diabetes and the beneficial influence of insulin and amellin.

M. C. NATH and (MISS) BHAVANI BELAVADY, Nagpur.

Continued injection of sodium aceto-acetate in the normal animals (rabbits) brings about a progressive increase in the urea and inorganic phosphate of blood. Blood cholesterol shows alternate increase and decrease. Urea and inorganic phosphate of urine also are found to increase considerably. Both amellin and insulin help to bring the concentration of these constituents to the normal limits, the effect of amellin being much greater than that of insulin.

4. Effect of Feeding Thyroprotein and Removal of Tablets on Lactation Induced by Implantation of Stilboestrol.

A. Roy, S. Bhattacharya, S. N. Luktuke and P. Bhattacharya, Izatnagar.

A group of virgin goats were implanted with Stilboestrol tablets. Removal of all stilboestrol tablets left in situ after the induced lactation curve had reached its peak caused a considerable increase in milk yield. This increase in milk yield was not due to greater intake of food following the disappearance of the inhibitory influence of Stilboestrol on food intake, because this was kept at the same level throughout the experimental period. Feeding of iodoprotein after the stillboestrol induced lactation curve had reached its peak appears to bring about increase in milk yield. Simultaneous feeding of iodoprotein failed to bring into milk, those goats in which lactation could not be induced by the implanatation of stilboestrol tablets.

5. Effect of Feeding Thyroprotein (Protamone) on Goat Semen.

D. P. Mukherjee and P. Bhattacharya, Izatnagar.

In some previous experiments it was observed that during the season characterised by high environmental temperature and humidity, 'the semen quality of farm animals is poor. An attempt has been made to improve the semen quality of goats during this season by administration of thyro-active substance. The experimental animals consisted of 14 adult goats which were evenly distributed in two groups on the basis of their semen production in the pretreatment period. The animals of the experimental were fed with 1 gram of thyroprotein (PROTAMONE) daily for a period of 16 weeks during May to August 1949. The semen samples from both groups of animals were examined for the following attributes,

(1) Volume,
(2) Sperm concentration per c.c.
(3) Total number of spermatozoa per ejaculate.
and (4) Percentage of abnormal spermatozoa.

The 'reaction-time' was also recorded. It has been observed that sperm concentration increase considerably due to thyroprotein feeding. No appreciable difference have been observed in other characteristics.

6. A Study on the Corticomimetic Effect of Stilboestrol.

A. Ray, Y. R. Karnik, and P. Bhattacharya, Izatnagar.

Stilboestrol was implanted subcutaneously in a group of ewes in graded doses and left in situ for 64 days, while another group was kept as control. It was found to cause a statistically significant rise in the glucose and non-protein nitrogen content of blood. Plasma ascorbic acid content was not affected, but cholesterol concentration of plasma showed a progressive rise.

The moisture content of liver and adrenal showed slight decrease which is statistically significant in adrenal but not in liver.

Liver glycogen and fat content was significantly more in the treated group than the control. The difference in the liver cholesterol content was not significant statistically.

Ascorbic acid and cholesterol content of the adrenals of the treated group was lower than the control.

Some of the observations made provide further evidence to justify the theory that stilboestrol primarily augments adreno-corticotrophin secretion from the pituitary and thereby brings about a hyper secretory activity of the adrenal cortex. Hence the characteristic effects which are associated with the adrenal cortical hormones.

7. Collection and Preservation of the "Follicle Stimulating Hormone" like Substances in Urine by Ultrafiltration and their Biological Assay.

S. K. Gokhale, Poona.

In recent years much attention has been directed towards the determination of hypophyseal hormones in urine, as it affords a great diagnostic help in a variety of endocrine disorders. The ultrafiltration technique introduced by Gorbman (Endocrinology 27, 177, 1945) is relatively simpler as well as accurate, as compared to some other techniques like the alcohol precipitation method etc. The present work describes the technique in the light of the experience and observations in the application of the ultrafiltration method as follows: (1) the preparation of the collodion membrance, (2) the filtration vessel, (3) the filtration, (4) the collection, precipitation and extraction of the hormone, and (5) the assay, Results of FSH assays on urines of some normal and pathological subjects have been presented.

8. On the Colorimetric Method of Determination of Pteroyl Gultamic Acid and Related Compounds in Liver Extract Concentrate.

S. K. Ganguly, Calcutta.

In the colorimetric method of determination of Pteroyl glutamic acid and related compounds in liver extract concentrate according to the method of Hutchings *et al.*, (J. Biol. Chem. 168.705, 1947) uniform results were not being obtained in our hands. Treatment with chloride in presence of alcohol (90 per cent by volume) at PH 8.0 however, helped in the quantitative precipitation of the pteroyl glutamic acid and the related compounds from liver extract solution. Separating the precipitate by centrifugation and suspending the same in water, determination could be easily carried out by the above method using urea in place of amonium sulphate.

9. Influence of Phloridzin on Blood Vessels of Frogs.

N. M. Basu, Calcutta.

After pithing a toad weighing 110 g one branch of the aorta and lower part of sinus venosus were both nicked to drain out as much blood as was possible. A ligature was then tied round the other part of the aorta and the preparation perfused with cooled Ringer's solution. After thoroughly washing all the traces of blood a glass tube with a bulb at one end was pushed through fine incision in the sinus venosus, which was ligatured above the incision. The toad was then suspended by a clamp and Ringer at room temperature was perfused under pressure. Pressure of perfusion fluid was kept constant. Electric circuit was also established to record the flow of the liquid in the aortic consula. It was noticed that phloridzin brings about a marked constriction of blood vessels, adrenalin does it to a lesser extent and acetyl-choline brings about definite dilatation of blood vessels.

10. Hypoglycemic Action of Alloxan.

Sachchidananda Banerjee, Dulalpada Sadhu, Nareshchandra Ghosh and Haripada Chattopadhyay, Calcutta.

The initial hypoglycemia after the injection of alloxan is due to the liberation of insulin from the islets cells of the pancreas which are damaged by alloxan. Some claims have been made that alloxan hypoglycemia is extrapancreatic in origin and Houssay (1945) suggested that hypoglycemia is due to the lack of formation of glucose by the liver. Glycogen content of the liver of rabbits dying of hypoglycemic convulsions after the injection of alloxan was therefore determined and the value was compared with those of rabbits dying of hypoglycemic convulsions after the injection of insulin. The glycogen value of the livers of both alloxan injected and insulin injected animals were considerably diminished as compared to the values in control animals. There was no stoppage of glycogenolysis in the liver of alloxan injected rabbit. Both the alloxan injected and insulin injected showed similar symptoms and it is suggested that the alloxan hypoglycemia is pancreatic in origin.

Summary

11. Preliminary Investigation on the Pharmacological Action of Diamidino-Diphenylamine Dihydrochloride (a new remery for Kala-azar fever.)

GUPTA, J. C. & CHATTERJEE, M. L.

Pharmacological action of a new compound of aromatic diamidine (viz: *Diamidino-Diphenylamine Dihydrochloride*) prepared by Dr. A. J. Ewins, has been under investigation. Its toxicity LD50 has also been suggested in the present paper to be 22.5 ± 2.5mgm|kgm. The result of pharmacological action indicates that the drug has a depressant effect on blood pressure which is brought about greatly through central action and partly through peripheral parasympathetic effect and action on blood vessel. The drug seems to possess a direct depressant effect on plain muscle of blood vessel and also on myocardial tissue.

Biochemistry & Analytical Chemistry

12. Tocopherol Content of Edible Oils and Fats.

T. A. VEKATASUBRAMANIAN AND B. N. BANERJEE, Bangalore.

The tocopherol content of a few vegetable oils have been estimated by a modified Emmerie-Engel method. The tocopherol content of the fats were:—coconut oil, 0.03, groundnut oil, 0.52, Sesame oil, 0.48, cottonseed oil, 0.81, and a hydrogentated groundnut oil, 0.46 in mgms per gm of oil. The effect of hydrogenation on the tocopherol content of a number of samples of groundnut oil showed that there is no appreciable decrease in the tocopherol content due to hydrogenation. Cottonseed oil was found to contain the maximum tocopherol.

13. Studies in Indian Edible Oil—Coconut Oil.

K. RAMA MURTI AND B. N. BANERJEE, Bangalore.

In continuation of our previous work on groundnut and sesame oils cocoanut oil was investigated with special reference to the methods of extraction, storage, *in vitro* digestibility and stability of carotene and vitamin A dissolved in it. 25% of the market samples in Bangalore were found to be adulterated. The f.f.a. of the samples was not very high. Since samples with low f.f.a. showed high Kreiss value probably the products responsible for the latter were the primary products of disintegration. An oil with only 0.02% f.f.a. can be obtained if fresh kernels dried to about 3% moisture are crushed in the cold. Heat treatment of the kernels adversely affects the keeping quality of the oil. Steam distillation reduces the peroxide value of high f.f.a. oil. Samples of varying f.f.a. and kreiss value, showed very little difference in hydrolysis by lipase, probably due to the better emulsifying properties of the lower acids in cocoanut oil. In low concentration, the stability of vitamin A in cocoanut oil decreases proportionally with temperature, acidity, and peroxide value of the oil.

14. Nickel in Hydrogenated Fats.

T. A. Venkatasubramanian and B. N. Banerjee, Bangalore.

The nickel content of hydrogenated fat sold in the Indian market has been analysed. Over 200 samples collected from all over India gave values below one part per million Generally the value is 3 to 25 micrograms of nickel per kilogram. It may be said, therefore, that no harm need be feared from the presence of nickel in Vanaspati's sold in India.

15. The Antioxidant Activity of Sesame Oil in Hydrogenated Fats.

T. A. Venkatasubramanian and B. N. Banerjee, Bangalore.

As vanaspati sold in India now-a-days contains at least 5% of sesame oil or hydrogenated sesame oil, the effect of the addition of this constituent on the keeping quality of the product was studied. The storage property was judged by the induction period in an atmosphere of oxygen at 70°C. It was found that addition of 5% sesame oil to hydrogenated groundnut oil of melting point of 37°C. increased the stability by 70% and that of melting point 41°C. by 50%. In all cases, the end of the oxygen absorption coincided with the sample developing a peroxide value of about 12 m. equivalents per kg. However, the sesame oil must be from healthy seeds and cold drawn with acidity not more than 0.5%.

16. Determination of Vitamin A in Capsules and Tables in Tropical Conditions—A Comparative Study.

N. K. Iyengar and B. Mukerji.

Vitamins in capsules and tablets are imported into this country in considerable quantities. These are ordinarily stored under the tropical climatic conditions prevailing in the country.

A study of the deterioration of Vitamin A in tablets as compared with capsules has been made. Capsules and Tablets with potencies of 500 units were stored in the laboratory for a period of one year. The maximum temperature and humidity for the greater part of the year were 95°F and 80—90% respectively. At the end of one year a loss in potency of 50% in capsules as compared with 75% in tables was recorded. It appears from this study that as far as Vitamin A is concerned capsules are preferable to tablets for use and storage in the tropics.

This comparative study will be extended to other vitamins.

17. Determination of Vitamin A with the Lumetron Photo-Electric Colorimeter.

N. K. Iyenger and B. Mukerji

The possibility of employing Lumetron E F 402, the photo-electric colorimeter and fluorimeter for the determination of vitamin A with the use of the combined glass and special liquid filter has been investigated

The calibration graph which is a straight line showing the relationship between the logarithm of transmission and the potency of vitamin A has been prepared. For this purpose vitamin A with a potency of 1,500,000 units supplied by the B.D.H. was used.

In order to test the efficacy of the combined glass and special liquid filter, the absorptions of various concentrations of Arachis and Olive oils in Isopropyl alcohol not containing vitamin A, have been determined. It has been found that these oils in concentrations of 0.015% do not show any absorption while in concentrations above 0.03% there is a gradual increase in nonspecific absorption interfering with the estimation of vitamin A.

Oils not containing vitamin A were mixed with standard vitamin A to obtain concentrations of 3,300 and 1500 units per gram and then tested with the instrument both directly as well as after saponifaction. Preparations with potencies of more than 3,000 units gave very accurate results while those containing 1500 units gave considerably higher values, presumably due to nonspecific absorption of the oil being added on to the specific absorption of vitamin A.

Carr Price blue values on fish liver oils, vitaminized oils and capsules were determined and compared with the potencies as determined by the Lumetrón. The average factor for the conversion of blue values to International units is approximately 57 which should be used as a rough guide.

It is concluded that the Lumetron E F 402 with the combined glass and special liquid filter can be safely employed for the accurate determination of vitamin A in preparations with a potency of more than3,000 units.

Physiology

18. Studies on Vitamin A in Solution.

U. P. Basu and Sukhamoy Bhattacharya, Calcutta.

Vitamin A is now often being obtained in a concentrated form, and is being marketed in the form of a solution in edible oil. But as edible oil may develop rancidity on storage, the potency of vitamin may undergo deterioration on storage. This change can be controlled to a considerable extent by incorporation of some suitable antioxidant. A systematic study on the stability of vitamin A in different solvents and that again in presence of different antioxidants in varying concentrations have been studied and are being described in the present paper.

In the course of the investigation it has been noted that unsaturation in diluent is not the sole cause of deterioration of Vitamin A molecule in solution. The antioxidant (phenolic) is found to exert a better effect in protecting the vitamin A molecule when the system contains an ester or glyceride molecule. Systems studied are arachis oil, ethyl oleate, ethyl stearate, glyceryl monolourate, and liquid paraffin. Antioxidants used are monomethyl hydroquinone and propyl gallate.

19. A Comparative study of acid and Enzymic Extractions of Nicotinic acid from Foodstuffs.

Kamala (Bhgvat) Sohonie and U. C. Misra, Bombay.

A procedure for the extraction of nicotinic acid from foodstuffs with 2 N Hcl and with an enzyme preparation from the pigs' intestinal mucosa has been described.

The two modes of extraction have been shown to yield different values for nicotinic acid—enzymic extraction of pulses yielding higher values for nicotinic acid, while acid extraction of oil seeds and cereals gave bigger values. The discrepancy has been suggested to be due either to the presence of an alkali labile precursor of nicotinic acid or a non-specific chromogen. Groundnut, barley and black gram have been found to contain a precursor.

Whether this precursor is biologically active for man is not known, but it has been suggested that the values for nicotinic acid obtained by the enzymic extraction of foodstuff, may represent, the amount that is biologically available for man.

20 On the Estimation of niacinamide by Cyanogen Bromide Reaction.

N. RAY, Calcutta.

A critical study of the cyanogen bromide method of estimating niacin and its amide has been made. Control of temperature within the limit of 22°C. in developing the colour of maximum intensity and stability is found to be an indispensible factor. Sulfanilamide may replace aniline. Moreover it is found that sulfanilamide develops a colour of higher intensity than aniline.

21. A Study on the Reducing Substance of Semen.

A. ROY, Y. R. KARNIK, S. N. LUKTUKE, S. BHATTACHARYA AND
P. BHATTACHARYA, Izatnagar.

The concentration of total reducing substance and fruetose present in semen obtained from buffaloe-bulls, goats and rams have been estimated by the method of Hagedorn and Jensen and Roe respectively. The ascorbic acid content of semen of buffalo bulls and rams has been estimated by the method of Bessy and King. The mean total reducing substance, fructose and ascorbic acid content of buffalo bulls is 875, 615 and 3.7 mg. % respectively. By difference the concentration of nonfructose residue is 260mg%. Corresponding figures for ram are 623, 529, 5.10 and 94 mg %. The total reducing substance and fructose content of goat semen is 548 and 465 mg %.

Nutrition

22. Biological Value of Common Fish Proteins in Orissa.

K. SUBRAHMANYAM AND S. M. BANERJEE, Cuttack.

The Nitrogen balance sheet method of Mitchell as modified by later workers was used in the determination of Biological values of Hisla, Prawn, Rohi and Katla—the most common varieties consumed in Orissa. They were found to be:—

Hilsa	75.5%
Prawn	64.6%
Rohi	58.0%
Katla	51.0%

23. Effect of Heat Treatment and Acid Extraction on B. V. of Fish Proteins and the Presence of a possible Anti-enzyme which tends to lower B. V.

K. SUBRAHMANYAM AND S. M. BANERJI, Cuttack.

Biological values of common fish proteins were found to progressively increase after drying at temperatures from 60 C. to 10° C. The same increase in B. V. can be effected by removing a certain factor present in the fish meal by extraction with HCI (PH—4.2). The presence of an inhibitor in the extract which is responsible for the low B. V. (when the fish is dried at a lower temperature) can be demonstrated by adding the acid extract to the fish meal dried at a higher temperature of 100° C. when the high B. V. is lowered. The mechanism of action of the inhibitor appears to be by retarding the tryptic activity.

24. The Increase in Ionisable Iron in Various Vegetables after Intestinal Digestion.

K. Subrahmanyam and S. M. Banerji, Cuttack.

Doubts have been cast regarding the indentity of utilisable iron with ionisable iron. Samples of different foods, of which the ionisable and total iron were previously determined were digested with intestinal mucosa of sheep at 37.5° C. for 6 hours at pH 8 under anoerobic conditions. There was an appreciable increase in the ionisable iron possibly due to enzymic activity, which converts part of the non-ionisable iron into ionisable iron. The increase in the quantity of ionisable iron after digestion explains how such foodstuffs were found to contain more utilisable iron than is warranted by their previous low content of ionisable iron.

25. Studies on the effect of Germination on the Phytin Content and Phytase Activity of some Common Indian Pulses.

Sachchidananda Banerjee and Nirmalendu Nandi, Calcutta.

Phytin content and phytase activity of four varieties of pulses (*Phaseolus mungo, Phaseolus radiatus, Cicerarietinum and Dolichos lablab*) have been estimated both before and for varying periods after germination. Phytin content gradually diminished along with the increase in the phytase activity of the germinating pulse which was maximum either on the third or on the fourth day of germination.

26. Studies on the Biosynthesis of Nicotinic Acid. Biosynthesis of Nicotinic Acid by Germinating Pulses.

Sachchidananda Banerjee and Ramaprasad Banerjee, Calcutta.

A number of cereals and pulses have been shown to elaborate an increase amounts of nicotinic acid during germination. Pulses show a regular increase whereas with cereals the rise is comparatively small.

Trigonelline content of *phaseolus mungo* has been found to diminish to a considerable extent in contradistinction to the rise in the nicotinuric acid content and nicotinic acid content during the process of germination.

Chloretone and tryptophane have been found to enhance the production of nicotinic acid in germinating *phaseolus mungo* while ornithin, valine, methionine, phenylalanine, cystine, isoleucine, menthol, camphor, barbitone, pyridoxine and choline have no such effect.

An alkali-labile precursor of nicotinic acid claimed to be present in wheat bran has also been found to be present in barley and paddy but not in maize. This is found to be diminished during the process of germination. This precursor is absent in pulses.

27. Dietary Habits of Depressed Class (Dusadh & Chairo) in Palamau.

S. B. Lal, Patna.

Dusadh and Chairo belong to the depressed classes (Harijans). No studies regarding their dietary habits have been made so far in this province. The present paper deals with the dietary habits of those persons residing in the district of Palamau. With the diet surveys nutritional survey of the children of the same families were also carried on. 25 families of each of the Chairo and Dusadh consisting of 121 and 136 members were carried out. Economically they belong to the very poor strata and the daily income per consumption unit in annas was 1.4 to 2.3 only. The calorie intake was strikingly low and 84% of Chairo and 60% of Dusadh were consuming less than even 2,200 calories as suggested by Nicholl's. There was very low intake of protective foods. Consumption of milk was low and there was complete absence of flesh food, oils and fats. When compared with other sections of different castes and groups of the province of Bihar, Chairo and Dusadh were found to be poorer and consuming less than the other groups of population who have been surveyed.

28. Use of Defatted Groundnut Cake as food.

S. B. Lal and A. Bose, Patna.

Groundnut has long been used as human food but the excessive fat content in the kernel limited its use in large quantities. In the investigation under report an attempt was made to determine the amount of pulverised defatted kernel which could be consumed by adults without loss of health or digestive disorders. The investigation has indicated that upto a maximum of 1.5 oz. of the defatted ground nut kernel can be consumed daily with safety if it is mixed with wheat flour and cooked as chapathi (unleavened bread). Such chapathis were found to be palatable. Mixture of the defatted kernel in the form of thickening agents to pulse gruel or vegetable curry did not evoke a favourable response from the consumers. The feeding trials were held in a local orphanage. Sweets prepared with defatted kernel, Bengal gram flour and sugar with added fat were relished by the consumers.

29. The Effect of Diet on the Susceptibility of Rat to Rats Leprosy.

Kamala (Bhagvat) Sohonie, Bombay.

The effect of diet on the susceptibility of rats to rat leprosy has been tried. It has been observed that the susceptibility of rats to rat leprosy is not dependent on the type of the diet, further a supplementary supply of the vitamin B complex did not— increase the resistence of rats to this infection.

30. Ascorbic Acid content of Ovary and Corpus Luteum during various stages of Oestrous Cycle and early Pregnancy.

A. Roy, S. N. Luktuhe, P. Bhattacharya, Izatnagar.

The ascorbic acid contents of the ovary obtained from she-buffaloes at various stages of the oestrous cycle have been estimated. Of the two ovaries from the same animal the one freshly ovulated was found to contain 19.38 mg|100 g and the other 15.56 mg. The higher concentration in the former was found to be statistically significant. The ascorbic acid content of the ovaries in various other conditions studied was found to be of the same order.

Persistant Corpus luteum, compared to normal Corpus luteum, is characterized by a very low concentration of ascorbic acid.

Ascorbic acid content of Corpus Luteum obtained from pregnant animals did not differ from that obtained from non-pregnant animals.

31. Effect of Vitamin B1 on Circulation.

S. M. Banerji, S. Tej and J. Senapati, Cuttack.

The following methods were used:

(i) Frog's heart perfusion,
(ii) Dog's blood pressure,
(iii) Direct electrogram of frog's heart.

As a result of these studies it is found that Vitamin B1 has the effect of initial depression followed by accleration and augmentation of the heart beat. The depression is less marked after previous atropin administration. The blood pressure is not much affected. In minute doses the depression and stimulation effects on heart are not seen. It is proposed to extend the work on human beings.

32. Quality of Blood in Women Medical Undergraduates.

(MISS.) S. CHAUDHURI AND K. MITRA, New Delhi.

An attempt was made to study the concentration of the more important constituents in the blood of 30 apparently healthy undergraduate students at the Lady Hardinge Medical College. The average Hb value (Sahli) was found to be 10.5g|100ml with a maximum of 12g and a minimum of 8.5g. The average RBC Count was 4m. per cmm, the lowest figure recorded being 3.6m and the highest 5.2m. Plasma protein concentration was estimated by Van Slyke's specific gravity method. In fifty percent of the subjects protein figures did not come up to 7g|100ml, even a figure as low as 4.5g has been recorded. The albumin-globulin ratio was in the order of 2: 1. Inspite of the fact that no published figures for plasma protein value of adult Indians are available the sum total of the observations tend to confirm the belief that the general standard of health of the people has appreciably deteriorated within the recent years.

33. Haematological studies including Plasma Protein values in Nutritional Anaemia.

(MISS.) S. CHAUDHURI AND K. MITRA, New Delhi.

This study was undertaken to investigate the changes effected in the quality of blood of women suffering from Anaemia presumably caused by malnutrition. Altogether 35 women weighing 112-120 lbs each were examined of which 15 were pregnant. Dietary history revealed that the daily calorie value of their diet at home ranged from 1000 to 1600 on a liberal estimate. Haemoglobin concentration was below 50 percent in all these cases and the RBC Count was in the neighbourhood of 3 millions. Plasma protein concentration did not come up to even 5g|100ml in two-third of the subjects. It was significant to note that such low figures were associated even with low blood volumes. Albumin-globulin ratio ranged from 0.7: 1 to 3.5: 1. The albumin-globulin ratio was lowered inspite of the fact that there was no urinary excretion of albumin. An apparent correlation could be discovered between the plasma protein and haematological values. The subjects were put on high protein diet and protein hydrolysates by mouths. The response was very favourable with regards to plasma protein concentration and albumin-globulin ratio. Medication with iron liver extract or Folic acid either alone or in combination was not as effective as when proteins were added.

34. Hematopoetic Property of Iron in Autoclaved Soyabean and Soya-Milk and its Utilization in Normal Rat.

K. SUBRAHMANYAM, MISS. VANAMALA SATHE AND S. S. DE, Bangalore.

The hematopoetic activity of autoclaved Soya bean and processed soya-milk was compared with Ferric chloride on growing rats by following the haemoglobin level and iron stored during the experimental period. It was found that 92.5 per cent of ionizable iron in autoclaved soyabean is utilizable for haemoglobin regeneration and the iron in the autoclaved soyabean is about 90 per cent ratained as compared to Ferric chloride. In the case of soya-milk the values were the same as that of autoclaved soya-bean.

35. "Investigations into the Dietary Habits of the Aboriginal Tribes of Abor Hills (Assam)"

P. N. Sengupta, Calcutta.

Investigations into the dietary of 46 families consisting of 304 persons and on the general living conditions, economic status, education and food habits of all the 507 families consisting of 2203 persons of ten villages of Abor Hills on the Indo-Tibetan frontier were carried out during the winter of 1948-49. Males and females were found to be in the ratio of 1:1 to 1:1.3 and the children were 24-29% of the total population. 22.4 to 58.8% boys were receiving free primary education. Paddy was mainly raised in the lower regions but *Annyat* (*Coix Lachryma*) was the main crop in the upper regions. 39-70% families had sufficient food grains raised from their own field for the year's consumption. The diet surveys were carried out for 7 days in each family and the intake of various kinds of foods as well as of the different nutrients present in these foods were calculated on per consumption unit (C. U.) per *diem* on the basis of the League of Nations scale of the family coefficients. *Apong*, a beverage from fermented cereals, contained 2-4% alcohol and many nutritive principles. Milk, oils and fats, sugar and jaggery, pulses and condiments besides chillies were not used as foods and leafy vegetables constituted the main 'protective food'. Calorie consumption did not exceed 4000 in any family. In group I and II average calorie intake was 3115 and 2810 and of these respectively 91.6% and 93.9% were derived from the cereals. 33.3% and 57.9% families of these two groups were short of minimum requirement of calorie. Average protein intake though adequate *i.e.* more than 10 g, yet the animal protein was only 2.5-15%. Average Ca, P and Fe intake were: Group I-Ca-1.12 g, P-3.39 g, Fe—32.3 mg, Group—II—Ca-0.88g, P-2.98 g and Fe—29.3 mg. More than 50% families were deficient in carotene and vitamin A intake. Following were the quantities of vitamins provided by the diets: Group-I-vitamin B1—1.6 mg., Riboflavin—0.31 mg, Nicotinic acid—37.3 mg and vitamin C—82.7 mg. Group II—Vitamin B1—1.4 mg, Riboflavin—0.25 mg, Nicotinic acid—33.5 mg and vitamin C—49.3 mg. Anthropometrical measurements revealed that the children were heavier than the children of the Indian plains but their weight was at par with those of the American children.

36. Effect of Proteolytic Inhibitor on the Supplementary Effect and Biological Values of Different Varieties of Soya-bean.

S. A. Rahaman and S. S. De, Bangalore.

Thirty varities of Soyabean have been examined for their proteolytic inhibitor content and a difference was observed between different varieties. The biological value and supplementary effect to poor rice diet was found to vary with their inhibitor content. S. B. Pyneagne with 24.02 degree of inhibition has a biological value of 77.91 and supplementary value of 5.7 while S. B. 3 Black having higher degree of inhibition (39.03) has lower biological value and supplementary effect the value being 60.8 and 4.9 respectively.

37. Studies on the Nutritive Value of Soyabean.

Miss, S. Gowri Devi, J. Ganguly & S. S. De, Bangalore.

The effect of germination on the nutritive value of protein of Soyabean was determined by rat growth method and it was found that biological value of raw soyabean was 0.95 while that of bean germinated for 48 hours was 1.34. The biological value of proteins in soyamilk prepared from 48 hours germinated bears was found to be 1.40 as against 1.44 of the proteins of cow's milk.

General Physiology

38. A Study on Saliva in man.

M. L. Chakraborty and S. K. Sen, Calcutta.

An investigation into the ptyalin activities of saliva of man has been carried on. Wohlgemuth technique as modified by E. C. Dodd (British Journal of Experimental Pathology 1922, iii, 133) has been followed. The ptyalin content varied from 2650 to more than 20,000 units. From the investigation so far carried on, there has been found no indication of the Ptyalin content being more in vegetarian than in non-vegetarian. It would, however, show variations according to the stimulus used.

39. Normal Electrocardiogram in Orissa.

S. M. Banerji, S. Tej and J. Senapati, Cuttack.

Electrocardiogram of 50 healthy young men-average age 19 were taken by G.E.C. aapparatus and Phillip's Cardiotron. The curves obtained by both the instruments from the same person gave identical curves. The various components of the E.C.G. were critically analysed and their average, minimum and maximum readings were noted for comparison with literature and for use as nomal standards here. The following is a brief summary of the findings:—

Cardiac cycle	76 sec. (minimum. 52; maximum 1.04)
Heart rate	79 per minute, (minimum 58, maximum 115)
Rhythm	Regular 37, Sinus arrhythmia 13
P	Average duration .08 sec., Average height 1.17mm Inversion of P3 one case only.
P. Q interval	Average maximum .15 seconds (minimum .12 Maximum .18)
QRS complex	Average duration .0768 sec. Average maximum height 8.89 mm (minimum 4, max 14). L. A. D. present in 13 cases, R.A.D. present in 3 cases, R3 notched in 7 cases, Q3 prominent in 5 cases (Q|R 1|3 to 1|7).
QT—ventr. systole	Average duration .35 seconds (minimum 42. Max. 27).
St segment	1 to 3 mm above isoelectric line in 7 cases 1 mm down in one case. Concave in 8 cases, convex in 9, flat in the rest.
T	Maximum average duration .20 sec. Maximum average height 2.69 cases T3 inverted 14 cases.
TP—diastole	Average duration .26 seconds (minimum .08 Max. 52).

40. Gelatin as a Transfusion Material in Experimental Haemorrhagic Shock

M. Damodaran, E. K. Narayana, Gurdas Singh & M. B. Gharpure,
Poona.

Gelatin prepared in the laboratory from the long bones of goats has been transfused as a 6% heat sterlised aqueous solution in 5% glucose and 0.9% sodium chloride at pH 7.0, in amounts of 250 cc. in dogs (average weight: 12 kg.) and 75 cc. in cats (average weight: 3 kg.) subjected to severe haemorrhagic shock (rapid depletion of about 50% blood volume) and compared with glucose saline. Observations have been made of the blood pressure and respiration of the animals from the beginning of the hæmorrhage till 3 hours after the end of the transfusion or the death of the animal, whichever was earlier.

It has been observed that gelatin, unlike the crystalloids, maintains a large measure of the resuscitated blood pressure and helps the animal to survive shock. No alarming respiratory disturbances have been noted. Some gradual lowering of blood presure observed during the post transfusion period was attributed to the diffusible nitrogen content of the gelatin. The work is being continued by extending observations to blood volume changes as well, with preparations of gelatin obtained by different methods of processing.

41. Testing 'Local Anaesthetics' by "The Frog's Sciatic Nerve Sensory Block" Methods.

Ranjita Aiman and M. B. Gharpure, Poona

While testing the local anaesthetic property of some compounds by the above method it was not found possible to obtain comparable results. The factor responsible for this, was thought to be the weight of the frog used which would influence the size of the nerve. No reference in literature as regards the choice of the frog with respect to its weight, could be obtained. From the results of four experiments given below it is clear that the weight of the frog used is a point of considerable importance, in the testing of local anaesthetics by the frog's sciatic nerve sensory block method.

COMPOUND	Weight of the frog. (in grams)	Time for the appearance of anaesthesia.
2:4 dimethoxy benzhydrylamine hydrochloride.	145	29 min.
" "	381	43 "
p p' dimethyl benzhydrylamine	175	34 "
" "	345	80 "

Further work on this point with a view to standardize this method, as far as the weight of the frog is concerned, is in progress. It is hoped that the work would be completed by the end of December, 1949.

42. Effect of Addition of Fresh Kephalin on the Sustenance of a Frog's Heart Beat by Perfused Ringer Solution.

N. M. Basu, Calcutta.

It is well known that if frog's heart be perfused with Ringer's solution at PH varying from 7.2, to 7.4, it continued to beat for a long time, but the heart becomes gradually hypodynamic, and the auricles and the ventricles, particularly the auricles, become gradually dilated. It is also known that the heart muscle contains more phosphatides (Lecithin and Kephaline) than sketetal muscle. It has been also shown that lecithin and Kephalin in colloidal solution can pass through animal membranes (Bloor). It was surmised that hypodynamicity might be due to slow diffusion into the perfusing fluid of lecithin and Kehpalin from the cardiac muscle. Accordingly. experiments were performed to ascertain whether the addition of lecithin or Kephalin would maintain the normal heart beat for a long time. It was found that lecithin had no effect but the addition of freshly prepared Kephalin (25 mg. in 100 cc Ringer) had a pronounced effect on the sustenance of normal well-marked heart beat for over 4 hours, after which the experiment was stopped.

43. Thyroid-Adrenal Interrelationship under certain Experimental Conditions.

D. P. SADHU, Calcutta.

The relationship that may exist between Thyroid and Adrenal glands have been studied under a wide variety of experimental conditions with about 200 albino rats. Feeding of thiouracil or|and Vitamin A, injection of dinitrophenols or|and thyroxine and their several combinations have been tried. It was found that where the thyroid weight decreased, the weight of the adrenals increased and vice-versa. This inter-relationship could not be ascribed to any indirect—effect on metabolism. This inter-relationship, however failed under certain toxic conditions and under conditions of stress such as exposure to cold. This inter-relationship may be of interest in the study of tyrosine metabolism since the latter is influenced by the hormones secreted by thyroid and medulla of adrenal gland.

44. Physiological Normals and their Deviations.

J. N. MAITRA, Calcutta.

A large number of human subjects have been studied with regards to their physiological functions. In the cardiological series it has been noticed that a simple pain spot may be due to epicritic stimulation or on the other hand due to very serious but early damage to heart, kidney or the liver. A plea has been made for the study of norms after mass radiography, mass encephalography or mass electrocardiography etc.

45. Certain aspects of the Physiology of Pteropus Ciganteus Giganteaus.

K. L. VERGHESE, Madras.

The body temperature of Pteropus, a fruit bat of the Indian Peninsula was studied by three hourly observations on temperature of this animal for some time. It was found to vary between 95 to 100 deg. F with an average of 98.37°. But when the environmental temperature was raised to 115° the body temperature rose to 107° but when the invironmental temperature was lowered to 40°F the body temperature remained stationary at 98°F. Minor's test and Aubert's test (ref. Yas Kuno) were performed to detect the presence of sweat but the result was negative. By inserting a needle in the carotic artery the B. P. was measured and found to be 100-140 mm Electrocardiograms were also taken for study. Pulse rate was found to be 428-461 and respiratory rate 90-100 per minute. Hæmatological studies were also made of the blood.

46. Post Operative Complications of Cataract Extraction as an Allergic Phenomenon.

S. N. COOPER AND B. P. CHAKRAVORTI, Bombay.

Some times severe inflammatory reactions have been noticed in the eyes after the operation for cataract. Verhoeff and Lemoine had observed that when such patients were tested with lens protein they were definitely hypersensitive to this material. Further when the subjects were desensitised by injections of lens protein a rapid improvement in the ocular condition followed. This allerigic phenomenon has been studied by the authors. Under the auspices of the I.R.F.A. in K. E. M. Hospital, Bombay. Lens antigen is being prepared from bovince eyes. Rabbits have been found to become hypersensitive to this lens protein. The different fractions of the lens proteins L.B.Y. have been isolated and efforts are being made to produce the respective anti-sera in order to determine which of these three factors is responsible for the antigenic property.

47. An Alterative Method for Stimulatine the Vagus Nerve for Tracing the Contraction of the Heart of Frog.

K. I. VERGHESE, Madras.

In the standard method of demonstrating the effect of vagus stimulation on the heart of frog (from the ventral aspect, vide Experimental Physiology by Harris D. T. 1941, page 54) there is a chance of stimulating the lavyngeal branch of the vagus nerve and the hypoglossal nerve along with the pulmocardiac branch. This will contract the larynx and the lower jaw of the animal and thus spoil the tracing of the cardiac contraction on the kymograph. So another method of exposing the vagus nerve so as to separate the pulmo-cardiac branch alone is explained here.

A cylindrical piece of paper or pith (covered over by black paper) is plugged into the frog as far as the stomach. Then the animal is nailed on its side with the fore-limbs at right angles to the body with its hind limbs crossed over each other. The supra-scapula and the scapula are removed to expose the brachial plexus and the vagus nerve. The plexus is cut off and pulmo-cardiac is separated from other surrounding tissues easily. A hooked electrode is inserted below the pulmo-cardiac branch alone and stimulated. An incision is made from the region of the lungs to the xiphisternum so that the heart can be exposed and apex of the ventricle can be hooked up to the lever for tracing. In this method there is no possibility for getting any other tracing, due to contraction of the various other related organs, as sometimes obtained by the first method. Secondly the pulmo-cardiace branch can be easily identified and separated.

Miscellaneous

48. Improvised Electrode Jelly for use E. C. G.

S. M. BANERJI, AND S. TEJ, Cuttack.

It had happened once that we had run short of the E.C.G. electode jelly tubes and the old ones were gritty and causing awful variation in the base line of our curves. The following composition was found to give as satisfactory results as the manufactured ones and is recommended for trial:—

Ordinary adhesive paste (Malay)
Glycerine a a partes equalies.
NaCI to make 9%

This can be applied by the brush supplied with the adhesive paste phials after the skin has been rubbed clean with absolute alcohol and dried.

49. Effect of Thyroprotein Feeding on the Reproductive Performances in Rats.

D. N. MULLICK, Izatnagar.

24 female rats were devided into two groups, in one group the stock diet was supplemented with 0.02% of thyroprotein and the other group was kept as control. Estrous cycle noted by vaginal smear, was short and the percentages of the successful matings were higher in experimental groups. The body weight gestation period, average number and the weght of the litters were same in both the groups. The addition of thyroprotein can be used in getting more litters in a life cycle in a female rat.

50. Biometric Measurements in Cattle.

D. N. Mullick, Izatnagar.

A study was made on the relationship of the heart girth measurments and the body weight of 153 Hariana cattle, 24 Murrah buffaloes and 38 Hill bulls. These animals were from the Institute dairy and the Nutrition shed, Izatnagar.

The coefficients of correlations between the heart girth and the body weight were 0.959, 0.982 and 0.605 for Hariana cattle, Murrah buffaloes and Hill bulls respectively, all were statistically highly significant.

A calculation of the regression equation on actual live weight and heart girth showed as straight line relationship. It was shown the difference between the observed and calculated live weight and was found that the difference was little.

51. Factors Influencing the Vitamin A Content and the Chemical Constants of Buffalo Ghee.

J. C. Sharma, Izatnagar.

Investigations were made on the influence of the method of preparation, stage of lactation, level of carotene ingestion and season on the vitamin A potency and the chemical constants of buffalo ghee.

The methods of preparation studied appeared to have practically no effect on the vitamin A potency or the chemical constants of buffalo ghee. Although the fat percentage in milk increased, the vitamin A content per gram of fat was found to decrease with progress of lactation. The saponification and the R. M. value showed a tendency to fall with progress of lactation, whereas no regular trend was observed in the case of Iodine and R. P. values.

Increase in the ingestion of carotene appeared to increase the iodine value of ghee. The saponification and R. M. values were slightly lowered whereas no definite trend was exhibited by the R.P. values.

Animals kept under identical conditions of feeding and management showed no marked difference in the output of vitamin A and the chemical composition of butter fat produced from the same buffalo in rainy and winter season.

52. Ascorbic Acid in Plasma and Milk of Bengali Women.

K. K. Bagchi, Calcutta.

Milk and plasma of twentyfive healthy lactating Bengali Women were analysed for Ascorbic Acid content. The subjects were selected from the 1st. to 7th month of lactation at which latter period the baby is usually weaned. The babies of these experimental subjects were quite healthy and thrived entirely on breast milk.

Ascorbic acid in milk varied from 4.9 mgm per 100 c.c. to 8.6 mgm. per 100 c.c., the average being 6.7 mgm. per 100 c.c. The plasma ascorbic acid varied from 0.6 mgm. to 0.98 mgm. per 100 c.c., the average being 0.77 mgm. There was a consistent relationship between the ascorbic acid value of plasma and milk, the average ratio being 1 :8.6.

Judging from the ascorbic acid value of milk, it can be safely declared that supplement of ascorbic acid to breast fed baby is not at all essential, if ofcourse the diet of the mother is adequate. For example a five month baby will get 48 mgm. of ascorbic acid daily from mother's milk, whereas the requirement is 30 mgm. only. (Recommendation of National Research Council of U.S.A.—1948)

53. Riboflavin Content of Dired Silk Worm.

A. K. Ghosh, K. Rajagopal, and G. R. Amritmahal, Calcutta.

It was observed by Dr. A. C. Chatterji (Formerly Director of Health Services, Government of West Bengal) that in Japan the school children in poor Districts were given dried silkworm powder as a 'tonic' and the general appearence of the children was very good. After the worm is used for making silk the rejected part is dried and can be crushed into a powder. Protein content of the dried worm has been reported in the literature. No figures are available for riboflavin.

A sample of dried silkworm (Bomb Mori), after the sik was extracted, was obtained from a Silk Factory in West Bengal, through the courtesy of Dr. Chatterji. Microbiological method of assay using lactobacillies Caseii (American type culture collections, Number 7469) as the test organism was adopted. Methods of extraction, sampling, preparation of standard and sample tubes and inoculation were the same as recommended by A.O.A.C. Growth of organisms after 72 hours incubation was measured by acidimetric titration using Cambridge pH metre. The results were as follows:—

Trials	gamma riboflavin per gram of sample.
1.	64.0
2.	64.8
3.	64.5
4.	64.5

30 gamma of riboflavin added to the extract of the sample and three trials for recovery of the added amount were made; it was found that 97.0 to 97-3% were recoverable.

It is therefore established that dried silkworm (a by-product in Silk industry) is a very rich source of riboflavin.

54. Thiamine and P_2O_5 Content of Rice.

K. K. Bagchi and K. Rajagopal, Calcutta.

Fifteen different samples of rice, as available in the local market were analysed for the thiamin content.

Phosphorus content (as P_2O_5) was also determined to find out whether any correlation exists between U_2O_5 and the thiamine figures.

Sample number	Thiamine V|Gm.	P_2O_5 Gm%	Sample number	Thiamine V|Gm.	P_2O_5 Gm%	Sample number	Thiamine V|Gm.	P_2O_5 Gm%
1	1.3	0.58	6	1.2	0.27	11	1.0	0.5
2	1.8	0.41	7	2.2	0.5	12	0.75	0.2
3	1.6	0.55	8	1.0	0.46	13	1.5	0.41
4	1.0	0.56	9	0.75	0.32	14	2.06	0.46
5	1.5	0.46	10	1.0	0.48	15	1.72	0.38

From the above table, it can be seen there is no correlation between the thiamine and P_2O_5 figures.

This can possibly be explained by the fact, that the scutellum of the rice grain, like that of wheat, is very high in thiamine content. In parboiled rice, the scutellum becomes very tough and even by milling, it is not removed. This fact was also verified by observing the germ site by a magnifying glass. The depression there in raw milled rice is concave while that in parboiled milled rice is almost flat. In milling of parboiled rice, much of the phosphorus content is removed, whereas proportionately thiamine is not removed.

55. Studies on Venezuela (Melinis Minuliflora, Beav) Grasses. Part II—Digestibility and Nutritive Value of Venezuela Grass Hay.

BARUA, J. N., AYYAR, N. K., & KEHAR, N. D., Izatnagar.

Feeding trials with Venezuela hay cut at two different stages of growth conducted on local bred adult sheep showed that the animals consumed proportionately a large amount of hay cut at the pre-flowering stage than at the flowering stage. This may be due to higher palatability of the grass owing to the leafy nature of the herbage.

The results of the metabolic trials show that the animals can make better utilization of the nutrients from Venezuela hay made from the pre-flowering stage than from flowering stage.

All the animals in both the experiments recorded positive balances of Nitrogen, Calcium and Phosphorus. The retentions of these elements in the pre-flowering stage were found to be appreciably higher than those of the flowering stage.

Hay made at the preflowering stage shows a better nutritive value than at the flowering stage.

37th INDIAN SCIENCE CONGRESS, POONA 1950

SECTION OF CHEMISTRY

PRESIDENT : DR. J. K. CHOWDHURY, Ph.D.

Abstracts

Inorganic Chemistry

1. Condition of Sparingly Soluble Salts of Copper and Silver in Gelatin.

A. C. CHATTERJEE *and* M. C. RASTOGI, Lucknow.

The condition of varous sparingly soluble salts of silver and copper in gelatin at various concentrations was measured and the percentage of cations of the respective salts was calculated. The percentage of ions in salts like ferrocyanide, ferricyanide, thiosulphate of silver and ferrocyanide, ferricyanide, borate, hydroxide and arsenate of copper varied between 0.0023 and 2.714, while in the rase of silver iodate it is about ten times the solubility. The low percentage appears to indicate that the sparingly soluble substance is not in the ionic condition as is required for supersaturation, but is in the colloidal state Further work is in progress in this laboratory, with a view to extend the investigation to a large number of sparingly soluble salts to elucidate the true cause of the phenomenon namely that the salts like silver chromate, lead iodide, silver iodate indicate a large percentage of the salt in the ionic condition as compared to the other salts which appear to be in the colloidal state.

2. Formation of Complex Compounds Between Lead Nitrate and Alkali Nitrates.—Part XI.

(*Transport Number Measurements*)

The Systems : a) $LiNO_3$-Pb (NO_3) 2-H_2O
b) $RbNO_3$-Pb (NO_3) 2-H_2O

M. R. NAYAR *and* C. S. PANDE, Lucknow.

In previous communications (Proc. Ind. Sci. Cong. Abst., 1949, *4*, 42-43) it has been shown that three definite complexes are produced in solution in the system : $RbNO_3$-Pb (NO_3) 2-H_2O, while no such formation could be detected in the system $LiNO_3$-Pb-(NO_3) 2-H_2O. In order to have an additional confirmation and also to have quantitatively comparable idea of the behaviour of $LiNO_3$ and $RbNO_3$, experiments on transport number of Pb ion were carried out.

The method adopted was the same as described in (Proc. Ind. Acad. Sci., A, 1948, *27*, 354-60). From the results obtained it is obvious that the percentage diminution in the transport number of Pb ion in the presence of $LiNO_3$ is of a very low order as compared with those in the case of KNO_3 & NH_4NO_3 systems. It is even less that that observed in the case of $NaNO_3$ system. In the case of KNO_3 & NH_4NO_3 systems the percentage change varied from 35% to 72% while even in $NaNO_3$ system the maximum was 18%. But in $LiNO_3$ system the maximum percentage change was only 7%. This means that the tendency for the formation of complex compounds in $LiNo_3$ is even less than system that in the case of $NaNO_3$.

On the other hand in $RbNO_3$ system, the percentage change effected in transport number of Pb ion was 38% to 75%, which is even slightly more than that observed in the case of KNO_3 system. This clearly indicates that the tendency for the formation of complex compounds in $RbNO_3$ system is even more that in the case of KNO_3 system.

Thus we find the formation of complex compounds between lead nitrate and alkali nitrates seems to be conditioned by the order of alkali metals in the Periodic Table.

3. Physico-Chemical Investigations on the Complex Formation between Pyrophosphate Ion and Beryllium Ion in Solution.

B. C. HALDER, Calcutta.

The author has studied the complex formation between pyrophosphate ion and beryllium ion in solution by different physico-chemical methods such as transport, thermometric, conductometric, P_H-measurements and cryoscopy in saturated sodium sulphate solutions. It has been proved conclusively that in solution containing excess of alkali pyrophosphate and beryllium salt, anionic complexions having beryllium in the anion are present. The complex ions are of the type $[Be(P_2O_7)]^{-2}$ and $[Be(P_2O_7)_2]^{-6}$ and are found to exist in simple monomeric form. In presence of excess of pyrophosphate ion, the complex formation may be represented in a step-wise manner as follows:

$$Be^{+2} + P_2O_7^{-4} \leftrightarrows [Be(P_2O_7)]^{-2}$$
$$[Be(P_2O_7)^{-2} - P_2O_7^{-4} = [Be(P_2O_7)_2]^{-6}$$

4. Formation and Stability of Cobaltic Biguanide Complexes.

PRIYADARANJAN RAY *and* ANIL KUMAR DEY, Calcutta.

Cobaltic tris-biguandie and tris-phenylbiguanide complexes have been found to dissociate by stages as tris ⟶ bis ⟶ monobiguandie complex ⟶ Co^{+++} in solution. Reversibly their formation also occurs in a similar manner by successive stages. The instability constant for each of these individual complexes— the co-ordinatively saturated and partially saturated ones— has been determined from a study of the equilibrium constants of the reactions between the complex ions and hydrogen ion, which occur as:

$$[Co(BigH)_3]^{+++} + H^+ \longleftrightarrow [Co(BigH)_2]^{+++} + BigH_2^+$$
$$[Co(BigH)_3]^{+++} + H^+ \longleftrightarrow [Co(BigH)]^{+++} + BioH_2^+$$
$$[ffo(Bigh)]^{+++} + H^+ \longleftrightarrow [Co]^{+++} + BigH_2^+$$

where BigH = a molecule of biguanide or phenylbiguanide, that is equal to $C_2N_5H_7$ or $C_2N_5H_6Ph$.

The individual equilibrium constants, k'_3, k'_2 and k'_1, were obtained from p_H measure ment of solutions to which known amounts of acid were added and from the E.M.F. measurement in presence of cobaltous ions for the Co^{+++} — Co^{++} system.

Similarly, the dissociation or the formation of individual complex ion can be represented by the equations :

$$[Co(BigH)_3]^{+++} \longleftrightarrow [Co(BigH)_2]^{+++} + BigH^+$$
$$[Co(BigH)_2]^{+++} \longleftrightarrow [Co(BigH)]^{+++} + BigH^+$$
$$[Co(BigH)]^{+++} \longleftrightarrow [Co]^{+++} + BigH^+$$

while the corresponding instability constants are denoted by k_3, k_2, and k_1 respectively.

The first and the second acid dissociation constants, k_1^* and k_2^* of biguanide, correspond to the equations :-

$BigH_2^+ \longleftrightarrow BigH + H^+$ and $BigH_3^{++} \longleftrightarrow BigH_2^+ + H^+$. These were also determined from pH measurements.

The instability constants, k_3, k_2 and k_1, were then clculated by the relation,

$$k_3 = k'_3 k_1^*, \quad k_2 = k'_2 k_1^* \quad \text{and} \quad k_1 = k'_1 k_1^*.$$

The overall instability constant K is then equal to $k_3 . k_2 . k_1$ or $K . k_1^{*3}$, where $K' =$ overall equilibrium constant $= k'_3 . k'_2 . k'_1$.

The overall instability constant K for cobaltic tris-biguanide and cobalitic tris-phenylbiguanide complexes have been found to be equal to 7.3×10^{-50} and 2.7×10^{-55} respectively. These are much smaller than the instability constants for cobaltammines as determined by Lamb and Larson (J.A.C.S., 1920, *42*, 2024), who found for the hexammine cobaltic complex a value of 2.2×10^{-34} only. This is in perfect agreement with the nature of the biguanide complexes as salts of the inner metallic type, which, as is well known, represent the most stable class of co-ordination complexes. It will be observed further that phenylbiguanide gives rise to a somewhat more stable complex than the simple biguanide.

5. Studies in Niobium and Tantalum Part V Tartratoniobates of Copper and Lead.

N. R. SRINIVASAN, Bangalore.

The tartrato complexes of niobium with the alkali and alkaline earth metals have been described previously (Srinivasan, Proc. Indi. Sci. Cong, 1948, Sec 4, p.5; 1949, Sec 4, p.98). The copper and lead compounds were prepared by double decomposition of a soluble salt of the metal with potassium tartratoniobate. A pale green copper tartratoniobate and a white lead tartratoniobate, were obtained. Analysis revealed the composition as

$$CuO.\ Nb_2O_5(C_4H_4O_5)_2\ 10H_2O \text{ and}$$
$$5\ PbO.\ 3Nb_2O_5(C_4H_4O_5)_6\ 20H_2O.$$

On the analogy of the barium compound, the lead salt was formulated as a basic compound. The properties of the compounds were studied.

6. Studies in Niobium and Tantalum.—Part VI. Dehydration of Tartratoniobates.

N. R. SRINIVASAN, Bangalore.

The compounds obtained in these studies were dehydrated in air and in vacuum to find out the loss in water by the substances at different stages. Dehydration in air was carried out by heating the substances to constant weight in an air oven maintained at different temperatures to a maximum of 135°C. Dehydration in vacuum was conducted in a specially designed apparatus which could also be used for measuring the vapour pressure of compounds. It has been found that some molecules of water are loosely bound and hence easily removed whereas there are other molecules which are more firmly bound and only removable with considerable difficulty. On this basis suitable structures have given been to the various compounds. The vapour pressure of the hydrates have been determined at 26°C. Isothermal dehydration of the higher hydrate in the case of the alkali tartratoniobates, revealed the absence of definite intermediate hydrates.

7. Studies in Niobium and Tantalum.—Part VII. Solubility Determinations

N. R. SRINIVASAN, Bangalore.

Studies on the solubilities of tartratoniobates were made in water, water-alcohol mixtures and tartaric acid solutions of different concentrations. The alkali salts were moderately soluble in cold water and highly soluble in hot water. They were insoluble in alcohol. Their aqueous solutions became easily superaturated and supersaturation was not released by freezing and introduction of nucleii, which explained the difficulties encountered in crystallisation. Further the time of contact of the solute with the solution influenced the quantity of the substance dissolved upto a maximum and with long periods, the solutions tended to become collodial as was demonstrated by the Tyndall effect. Adequate explanations have been offered for the abnormalities met with in solubility equilibria.

8. Studies in Niobium and Tantalum.—Part VIII. Degradation Studies.

N. R. SRINIVASAN, Bangalore.

It was observed that the alkali tartratoniobates, exemplified by the general formula R_2O, $Nb_2O.\ (C_4H_4O_5)_2\ nH_2O$ (R=Alkalimetal) (N=Variable number), decompose in aqueous solution on vigorous and continued boiling, throwing out tartaric acid and resulting in newer compounds. Quantitative studies have been conducted on the hydrolytic decomposition and the amount of tartaric acid formed. Reconversion to their original compounds seems impossible. These compounds have been separated and their identity and individuality as a new class of compounds, established by chemical analysis, microscopic examination of crystals and other tests. The following compounds have been prepared and studied :

$$2\ K_2O.\ 2\ Nb_2O5.\ (C_4H_4O5)_3.\ 13\ H_2O.$$
$$2\ Na_2O.\ 2\ Nb_2O5.\ (C_4H_4O5)_3.\ 13\ H_2O.$$
$$2\ (NH_4)_2O.\ 2\ Nb_2O5.\ (C_4H_4O5)_3.\ 12\ H_2O.$$

9. 5-chloro-8-Hydroxyquinoline as an Analytical Reagent.—Part. I. Estimation of Magnesium.

M. K. Bose, Calcutta.

A method for the estimation of small quantities of magnesium on the Spekker photoabsorptiometer, after precipitation of the metal with reagent is described.

10. Estimation of Mercurous Ions by Precipitation Method using Adsorption Indicators.

R. C. Mehrotra, Allahabad.

Tetraiodophenol sulphonphthalein has been described as a very suitable adsorption indicator for the titrations of chloride and bromide ions against mercurous ions. The new indicator gives sharper end points than the most suitable indicator so far described 'bromophenol blue' (Kolthoff and Larson, J. Am. Chem. Soc., *56*, 1881, 1934). It not only gives sharper colour change than any other indicator so far described, but also makes the titration possible in much larger concentrations of the acids. The end points in the reverse titration of mercurous ions by chloride and bromide ions also is sharper with the new indicator than with any of the previously described indicators. Similar to earlier observation (Mehrotra, Anal. Chem. Acta, *3*, 78, 1949), it has been shown that the forces between mercurous ions and the dye are chemical in nature and it is probably a case of surface compound formation.

11. Argentometric Titrations of Thiocyanate Ions Using Adsorption Indicators.

R. C. Mehrotra, Allahabad.

In a recent communication (Mehrotra, Anal. Chim. Acta, *3*, 69, 1949), bromophenol blue has been shown to be a very good indicator for the titration of thiocyanate ions against silver ions. It can be used upto a dilution of N/250 of the titrating solutions and even when the pH of the solution is as low as 3. The present communication describes a comparative behaviour of a number of new adsorption indicators—dichlorofluorescein, dibromofluorescein, nitrazine yellow, bromocresol green, chlorophenol red and tetraiodophenol sulphonphthalein—in the above titration. Tetraiodophenol sulphonphthalein has been shwn to be a very useful indicator and is found to be applicable at a pH as low as 2 and givs well defined and very sharp end points for dilutions as low as N/500.

12. Analysis of a Mixture of Cu, Cu_2O, and CuO.

S. M. Mehta *and* N. R. Bharucha.

No satisfactory method for the determination of Copper, Cuprous oxide and Cupric oxide in a mixture is known. The present method consists in extracting Cu_2O from the mixture by means of a hot saturated solution of KI. The Copper and Cupric oxide left over are dissolved in acidified ferric chloride solution and the resulting Ferrous iron titrated against standard $K_2Cu_2O_7$ using barium diphenylamine sulphonate as the internal indicator. The Copper in the mixture is thus determined. To determine Cu_2O in the mixture, the sample is treated with acidified ferric chloride solution and titrated against $K_2Cr_2O_7$ as mentioned previously. The amount of Cu_2O in the sample is obtained by substracting the number of ccs. required in this tisation from the number of ccs. required in the previous titration. For determining CuO in the mixture, the sample is dissolved in the minimum quantity of concentrated HNO_3 and the total coppe content determined iodimetrically. Knowing total copper, metallic copper and cuprous oxide, CuO can be calculated.

13. Studies of a Sample of Lepidolite from Bastar District, C.P.

R. K. Dutta Roy, P. K. Chatterjee *and* B. N. Sen, Calcutta.

Lepidolite is known to contain lithium, rubidium and caesium in small quantities along with soda and potash. Other minerals containing the above elements are triphylite, lithophyllite spodumene, amblygonite, petalite etc.

The occurrence of lepodilite in India is very much limited, the only important deposit being in Bastar State (now district) C.P. There are two separate deposits occurring as pegmatites one being about 400 yds. south of Mundaval (18°39′ : 81°56′) and the other one at a distance of near about 600 yds. in the SW. of this village. The materials obtained from these two occurrences are of massive nature and of lilac colour with pearly lustre. A representative sample of this mineral was chemically analysed and the Li_2O content was found to be 2.56%. Besides chemical analysis the mineral was subjected to spectroscopic examination and from the spectrograms it was found to contain a fair amount of rubidium and probably a little of caesium.

14. Estimation of Metallic Phosphides and Phosphine.

D. D. KARVE, K. K. DOLE, M. G. BADAVE, Poona.

Different methods of estimating phosphine have been compared and a new method of determination and quantitative estimation has been developed. Metallic phosphides are decomposed by dilute acids and the resultant phosphine is absorbed in a dilute solution of silver nitrate. The reaction between phosphine and the silver nitrate runs as follows :

$$8\,AgNO_3 + PH_3 + 4_2H\,O = H_2PO_4 + 8\,Ag + 8\,HNO_3.$$

Silver is precipitated as a brownish black precipitate and is then dissolved in nitric acid and estimated as silver nitrate by a standard potassium thiocyanate solution. Phosphine and the phosphides can be estimated accurately and even small amounts of phosphides can be determined by the method.

15. Reduction of Phosphates by Alumino-Thermic Reaction.

D. D. KARVE, K. K. DOLE, M. G. BADAVE, Poona.

In continuation of the work of reduction of sulphates the study of reduction of phosphates has been carried out. The reaction is complicated, primary, secondary, tertiary, simultaneous and consecutive reactions seem to take place. One of the important reaction products is the phosphide. The formation of the phosphide depends on the quantity of aluminium employed and the temperature that is attained during the course of the reaction. The larger the quantity of the aluminium used, the larger is the phosphide formed and the higher the temperature attained in the reaction the lower is the yield of phosphide. It seems that the reduction depends upon the following factors: (i) the cation of the phosphate, (ii) percentage of the aluminium used, and (iii) particle size of the reactants. Phosphates of the alkali metals and the alkaline earth metals do not react under the existing experimental conditions.

16. Reduction of Chromates, Borates and Allied Compounds by Alumino-Thermic Reaction.

K. K. DOLE, M. W. NENE. Poona.

In continuation of the work of reduction of sulphates and phosphates, the study of chromates, borates and allied compounds has been made in this paper. Heavy metal chromates are easilly reduced to metallic condition and the metals vapourize at the high temperatures of the reaction. The reactions are followed by chemical analysis, measurement of temperature of the reaction and propagation of flame through the reaction mixture. As is expected chromates react vigourously and the temperatures as high as 3400°C. are quickly obtained. Borates exhibit very slow reactions and the rate of propogation of flame in the reaction mixture is also slow. It seems that the velocity of propagation of flame through the reaction mixture would be proportional to the reaction velocity itself.

17. Investigations on the Extraction of Potash from Felspar.

ESWAR RAJ SAXENA, D. S. DATAR *and* S. HUSAIN ZAHEER,
Hyderabad—Deccan.

Besides the method of digestion of felspar with lime under pressure, the other reactions which have been investigated in these laboratories for the extraction of potash from felspar are:—

(1) The digestion of felspar with sulphuric acid of different concentrations and

(2) Heating of felspar with calcium carbonate and calcium chloride.

While by the former method the yield of potash is poor viz., 3.4% irrespective of the concentration of sulphuric acid employed, that by the latter is about 60%.

18. Mechanism of the Reactions of Felspar with Calcium Oxide and Calcium Nitrate.

ESHWAR RAJ SAXENA, D. S. DATAR *and* S. HUSAIN ZAHEER, Hyderabad—Deccan.

The method suggested for the extraction of Potash from Felspar consists of digestion of this potash bearing mineral with lime or basic calcium nitrate under pressure. This method has been investigated in these laboratories.

The results show that the yield of Potash is directly proportional to the period of digestion and proportional to the square root of the digestion pressure.

Tentative equations to represent the reactions between Felspar and calcium oxide and also basic calcium nitrate have been given.

The process can be commercialized if valuable bye-products are obtained such as white cement which can be obtained from sludge if iron free lime is used for digestion.

Physical Chemistry

19. Silver Thio-Cyanate Electrodes.

R. K. PARIDA, S. ADITYA *and* B. PRASAD, Cuttack.

The similarity in the behaviour of the Thio-cyanate ions with halogens and the solubility of AgCNS lying between that of AgCl and AgBr led us to attempt the preparation of the thio-cyanate electrodes. Ordinary method of depositing AgCNS by electrolysis on Ag foil did not prove satisfactory. Spongy Ag was formed on Ag surface deposited electrolytically on platinum helix. On this AgCNS was deposited at 1 m/amp for 6 hours from 0.75 M NH_4CNS or KCNS soln. This serves very well for the purpose of titration of CNS with Ag. Even the presence of other salts such as NH_4 NO_3 does not shift the break. KCl also has no effect. The break coccurs as usual but if it is followed further second break corresponding to it also occurs. The error in comparison with ordinary volumetric method is not more than 1%.

20. Reduction Processes at the Dropping Mercury Electrode in Pulsating Fields.

K. S. GURURAJA DOSS *and* H. P. AGARWAL, Kanpur.

The work of Breyer and Gutmann on the effect of superimposing alternating fields on the reduction processes occuring at the dropping mercury electrode, has been extended to lead solutions. The work has been done at different frequencies of the alternating field. All the results obtained are interpretable on the basis of the diminution in the capacitative impedence of the dropping electrode as the half wave potential is approached as well as when the frequency of the alternating field increases. These results are largely confirmed by direct observations on phase shifts by means of the oscillograph.

21. Role of Indifferent Electrolytes in Electrode Kinetics.

K. S. GURURAJA *and* H. P. AGARWAL, Kanpur.

By studying the Kinetics of the electrode processes Randles observed that the rate constant for the discharge for the Zinc ion depended upon the nature of the indifferent electrolyte used in the experiment. It is shown that the variation in the rate constants can be interpreted plausibly on the basis of the variation of the Equilibrium potential of the different systems.

22. Ash Percentage in Indian Final Molasses from Electrical Conductivity Measurements at 35°C.

K. S. G. Doss *and* K. K. Gupta, Kanpur.

Thirtysix samples of molasses drawn from all over India were analysed for soluble ash and electrical conductivity. Equations have been worked out for correlating the ash content with two, three and four conductance measurements. The three conductance methods are slightly better than the two conductance method. The method involving the use of phosphoric acid is found to yield better correlaton than that using hydrochloric acid. The four conductance method is self defeating as it means experimental complications without any gain of accuracy.

23. Theory of Ash Determination by Three Conductance Measurements

K. S. G. Doss *and* K. K. Gupta, Kanpur.

A theoretical equation has been derived for the determination of ash by three conductance measurements. It is shown that the theoretical equation is equivalent to the equation derived for Indian molasses. The apparent opposite sign appearing with the term K_2 is the equation for Indian molasses as compared to the theoretical one has been explained. It is shown that the group C ash forming constituent are not of much importance in Indian Molasses.

24. Dissociation of Lead Nitrate in Aqueous Solution.

S. Nath, S. Aditya *and* B. Prasad, Cuttack.

It has been suggested by Davies that Lead Nitrate dissociates in two stages, that the first stage of dissociation $Pb(NO_3)_2 \rightarrow Pb(NO_3)^+$ NO_3 corresponds to that of strong electrolyte and that the second stage of dissociation $PbNO^+_3 \rightleftarrows Pb^{++} + NO^-_3$ to that of a weak electrolyte. Davies has measured the dissociation constant of the second stage of dissociation from conductivity data by making some approximations and finds it to be 6.47×10^{-2}. The results of Davies were checked by studying the e.m.f. of two kinds of cells.

$$Pb_x\,Hg_y \left| \begin{matrix} Pb\,(No_3)_{2c} \\ C_1 \end{matrix} \right\|\, \begin{matrix} \text{Satd} \\ NH_4\,No_3 \end{matrix} \,\left\| \begin{matrix} Pb(No_3)_2 \\ C_2 \end{matrix} \right| Pb_x\,Hg_y.$$

and

$$Pb_x\,Hg_y \left| \begin{matrix} Pb\,(No_3)_2 \\ C_1 \end{matrix} \right| \begin{matrix} Pb\,(No_3)_2 \\ C_2 \end{matrix} \left| Pb_x\,Hg_y. \right.$$

The liquid junction potential in the first kind of cells was estimated not to exceed 1 mill, volt. The e.m.f. of the first type of cell could be calculated on the basis of the assumptions that

1. liquid junction potential was negligible
2. Activity coeficient of Pb in lead nitrate solution could be calculated frcm the knowledge of the activity coeficient of $Pb(NO_3)_2$, KNO_3 and KCl at the same ionic strengths. The calculated e.m.f. agree with the measured results within experimental errors.

The e.m.f. of the second type of the cell is given by the formula

$$E = t\,\frac{3RT}{2F}\ln\frac{a_1\,Pb\,(No_3)_2}{a_2\,Pb\,(No_3)_2}$$

activity coefficient of $Pb(NO_3)_2$ which is required can be got from the Landolt's Tables. The e.m.f. could therefore be calculated if the transport number is known. Alternately the transport number itself can be calculated. We calcuated the transport number and found that it did not vary appreciably with concentration. If lead nitrate was dissociating in two stages the transport number would not have been constant but would have changed as it does in cadmium iodide Hence from this evidence, also $Pb(NO_3)_2$ seems to be completly dissociated.

25. Kinetics of Reactions in Liquid-Liquid Heterogeneous Systems.

K. K. DOLE, G. G. MAJUMDAR *and* M. D. BHATWADEKAR, Poona.

Reaction: *Sodium Thiosulphate—Iodine.*

Reaction between aqueous sodium thiosulphate and iodine dissoved in monchlorbenzene is studied as liquid-liquid heterogeneous reaction. It is found that the reaction is diffusion dominated. The temperature coefficient has the value 1.2 when iodine is in excess and 1.0 when sodium thiosulphate is in excess. The rate of diffusion seems to increase with increase in the concentration of iodine, while it remains unaltered on changing the concentration of sodium thiosulphate. When sodium thiosulphate is in excess the bimolecular formula is applicable.

26. Kinetics of Reactions in Liquid-Liquid Heterogeneous Systems Reaction: Sodium Arsenite—Iodine.

K. K. DOLE, G. G. MAJUMDAR *and* M. D. BHATWADEKAR, Poona.

Oxidation of sodium arsenite to sodium arsenate by iodine is studied in heterogeneous system by dissolving sodium arsenite in water and iodine in monochlorbenzene. The reaction was carried out with a constant surface of contact of the liquid phases-while the two layers were slowly stirred so as to ensure good diffusion. The reaction had to be carried out in presence of an alkaline medium in order to remove the hydriodic acid formed in the reaction. Small quantities of sodium bicarbonate were added for this purpose. This reaction is also a diffusion dominated one, with a temperature oefficient of about 1.2. It was however found that the temperature did not change even though the nature of the reaction changed from uni-to bimolecular state by changing the concentration of the reactants.

27. Kinetics of Amide hydrolysis.

V. V. WAKADE, G. G. MAJUMDAR *and* D. D. KARVE, Poona.

In continuation of the previous work (Proc. Ind. Sc. Cong., 1949, Part III, p. 76) hydrolysis of Acetamide and Propionamide has been further investigated in Formic Acid, Methyl Alcohol and N-Propyl Alcohol as solvents. The results obtained indicate that the peculiar behaviour of amides towards acid hydrolysis cannot be attributed to only one of the several factors suggested by the previous workers, such as the amide-imide tautomerism, acidity of the reaction mixture, activity of water etc. but to two or more of these factors.

28. Kinetics of Colour Development in Invert Sugar Solution.—Part II.

K. S. G. DOSS *and* S. K. GHOSH, Kanpur.

In an earlier work the Kinetics of colour development in invert sugar solutions of P^H 7 and at 98° C was investigated. In the present work the study has been extended to reactions in an alkaline medium (P^H 11.5) and at ordinary temperatures (28.5°C, 30.0°C, 38.4°C and 41.4°C).

The results show:—

(i) That the rate of colour development in an alkaline medium (P_H 11.5) and at the aforesaid temperatures is proportional to time.

(ii) That with a small increase in temperature the rate of colour development incseases remarkably.

(iii) That doubling the concentration of invert sugar in the reation mixtures nearly doubles the rate of colour development.

29. The Effect of Various Groups and Ring Complexes on Carbon-Tetrahedral Angle Dissociation Constants of Substituted Glutaric and Adipic Acids

L. D. TEWARI *and* J. D. TEWARI.

A comparative study of the dissociation constants of substituted glutaric and adipic acids has been made with the idea of determining the effect of various groups and ring complexes on carbon tetrahedral angle. The dissociation constants value of cyclohexane-1-acetic-1-propionic acid indicate that cyclohexane ring in it has been stabilised into either of its strainless forms in the unsymmetrical structure obtained by attachinng cylohexane residue to the βcarbon atom of the simple adipic acid. The similarity which existed between the values of the dissociation constant of dethyl glutaric acid (33.9) and cyclohexane-1-1-diacetic acid (33.4) can in no case be observed between the dissociation constants $\beta\beta$-diethyl adipic acid (163.8) and cyclohexane-1-acetic-1-propionic acid (41.6).

30. Magnetic Study of Inorganic Compounds of Trivalent Arsenic, Antimony and Bismuth and some Organometallic Compounds of Arsenic

Mata Prasad *and* L. N. Mulay, Bombay.

The magnetic susceptibilities of several chemically pure inorganic compounds of trivalent. As, Sb and Bi have been measured on a modified form of Gouy's balance. The molecular susceptibilities of compounds of these metals in combination with an anion are a linear function of the number of electrons in the cation. The susceptibilities of As^{+3}, Sb^{+3}, Bi^{+3} have been calculated from these graphs. The mean values obtained being $\chi As^{+3} = -15.60 \times 10^{-6}$, $\chi Sb^{+3} = -24.96 \times 10^{-6}$, $\chi Bi^{+3} = -41.6$ 10^{-6}.

Ikenmeyer's relation does not hold for the compounds of these metals. The graphs obtained by plotting the molecular susceptibilities of compounds of each of these metals against the total number of electrons give patterns which are strikingly similar. This indicates that the magnetic behaviour of these chemically related elements is also similar.

The magnetic susceptibilities of several organometallic compounds of arsenic have been measured. The susceptibility of trivalent arsenic has been computed from the molecular susceptibilities of some arsines of the type (R_3 As) using Pascals' corrected constants; the mean value obtained being -19.77×10^{-6}. Further investigation on compounds like the aryl and alkyl arsinic acids [R. As O $(OH)_2$], derivatives of arsenobenzene (R. As = As − R) and others is in progress.

31. Magnetic Susceptibility of the CH_2 Group in Different Homologous Series.

Mata Prasad, S. S. Dharmatti, D. D. Khanolkar *and*
S. P. Walvekar.

The susceptibilities of a number of monobasic aliphatic fatty acids belonging to a homologous series and their alkali and alkaline earth salts were determined on the modified form of Gouy's balance. From the results obtained, the susceptibility of CH_2 group has been calculated for each series.

It has been found that the value of χ CH_2 is constant for a given series of acids and their salts but is different for different series.

32. Diamagnetic Susceptibility of Ammonium Ion.

Mata Prasad, S. S. Dharmatti, C. R. Kanekar *and* M. G. Datar,
Bombay.

Magnetic susceptibilities of a number of ammonium salts of inorganic acids have been measured on the modified form of Guoy's balance. From the experimental data, the susceptibility of ammonium ion has been calculated by the method of average; this value is definitely lower than those reported in the literature.

The graph obtained by plotting the molar susceptibilities of ammonium salts against the total nuclear charge in the molecule, is definitely non-linear. This graph is very similar to those for the corresponding salts of the alkali metals. This indicates that the magnetic behaviour of ammonium ion is similar to that of the alkali ions.

A linear relation has been found to hold between the molar susceptibilities of salts of Li, NH_4 and K containing a common anion and the number of electrons in the cations. This relation has been used to calculate the susceptibility of the ammonium ion in combination with different anions.

33. Magnetic Susceptibilities of Hydrates of Boron Compounds.

Mata Prasad, C. R. Kanekar *and* **(Miss) L. S. Kamat**, Bombay.

Susceptibilities of a number of hydrates of different polyborates were measured on the modified form of Gouy's balance. The observed data of molar susceptibilities has been compared with the values calculated for the hydrates from the anhydrous salts on the basis of strict additivity. In the case of several hydrates of each polyborate, the deviation $(\Delta\chi_m)$ of the observed susceptibilities of the hydrates from the calculated values increases steadily though not uniformly as the number of water molecules (n) in the hydrates increases. The deviation per molecule of water of crystallisation $\left(\frac{\Delta\chi_m}{n}\right)$, however, decreases steadily as n increases. These deviations are probably due to the deformation caused by the water molecules as a result of binding with the cat—and anions in the hydrates.

The susceptibilities of water molecules when bound chemically to an anion are greater than that of water molecule attached electrostatically to a cation. Further, the contribution of susceptibility per mole of water of crystallisation attached to an anion is constant for several hydrates in which the water of crystallisation is attached to the anion.

34. Magnetic Study of Some Boron Compounds.

Mata Prasad, C. R. Kanekar *and* **(Miss) L. S. Kamat**, Bombay.

A number of compounds containing boron were prepared in a pure condion and their susceptibilities were measured on a modified form of Guoy's balance. Values for the susceptibilities of anions containing boron wers calculated by the method of averages. The average susceptibility values of the meta, tetra and penta borate ions are a linear function of the number of electrons in the ions. Values calculated for the susceptibility of tetra and penta borate ions by using the average values of the meta borate ion and the observed susceptibility of B_2O_3 are higher than the observed values of the tetra and penta borate ions. From the difference between the two values the extent of the depression resulting from the binding between each molecule of B_2O_3 and the meta borate ion to form the tetra borate and penta borate ions, is found to be constant for both the ions. This substantiates the view that there is a chemical relationship of the penta and tetra borate ion with the meta borate ion. The examination of the constitution of the hydrated decaborate ion in a similar way indicates that it is more closely related to the BO_2'' ion than to the BO_2' ion.

On plotting the molecular susceptibilities of the decaborates of Ca, Sr, and Ba against the number of electrons in the cation, a straight line is obtained. This linear relation has been used to calculate the susceptibility of the decaborate ion and the alkaline

35. Resonating Semipolar Single Bond. Part V. Interpretation in Terms of Wave Mechanics and Other Theories

Saiyid Shamim-Ahmad, Aligarh.

The idea of semipolarisation of single bond put forward earlier (Proc. Ind. Sci. Cong., 1948, Chem. Sec., Abst. No. 19) is explained in greater detail and shown to be different from Prideaux, Ingold and Sugden's formulation in that resonance is also assumed to be present between the half charges characteristic of the semipolar single bond if the two atoms are of strong, and about equal electron polarising nature. IN ORDER TO DIFFRENTIATE THE PRESENT VIEW FROM EARLIER IDEAS AND TO AVOID CONFUSION, THE TITLE OF THESE SERIES OF PAPERS IS CHANGED TO 'RESONATING SEMIPOLAR SINGLE BOND' IN PLACE OF 'SEMIPOLAR SINGLE BOND.'

The picture in terms of wave mechanical theory and the theory of electron as resonators is given to explain the colour present in most of the resonating semipolar single bond compounds e.g. Cl_2, NI_3, HOCl etc. The same idea is shown to explain the weakness of O-O, N-N bonds as also the almost constant distance between O-O, N-N and F-F despite the increasing nuclear charge. The change in colour of iodine solutions, the anomalous dipole moment and conductivity of the halogens is shown to be due to the stabilisation of one of the resonating forms by solvents. As mentioned earlier the same theory can explain the anomalous value of γ for coloured diatomic molecules.

36. A Possible Explanation of Joshi Effect.

SAIYID SHAMIM-AHMAD, Aligarh.

An explanation of Joshi Effect is put forward on the basis of the theory of the resonating semipolar single bond developed earlier to explain the anomalous colour, (molecular) reactivity, dipole moment in solution, ratio of specific heats for halogens etc. The theory postulates: I. Formation of a polarised wall complex which under the applied field can ionise at a lower voltage than the molecules in the bulk.

II. Under the influence of light this complex dissociates into neutral particles and possibly also into negative ions.

Ageing, influence of the nature of the gas, nature of surfaces, temperature, pressure are explained as influencing the formation of the polarised complex. Threshold potential is the ionising potential of the boundary complex. Fall in conductivity, influence of intensity and frequency of light non-dependence on selective absorption, suppression of high frequencies and positive Joshi Effect are explained as due to the break up of the boundary complex.

37. Solvent and Chain Transfer.

SADHAN BASU, JYOTIRINDRA NATH SEN *and* SANTI R. PALIT, Calcutta.

It has long been known that certain solvents reduce the molecular weight of the polymers formed in solution. Flory has assumed that this is due to the fact that the solvent molecules can transfer an atom or a group of atoms to the growing polymer radical. The reactivity of the polymer is thus transferred to the solvent residue which may in its turn propagate a new chain. Working on this assumption Mayo has deduced a relation for the polymerization of a monomer in solution.

$$\frac{1}{P} = C\left(\frac{[S]}{[M]}\right) + \frac{1}{P_o}$$

where P is the number-average degree of polymerization in solution, P_o that in the bulk, [S]/[M] is the mole ratio of solvent to monomer and C is a constant, called the chain transfer constant. Mayo has calculated the value of C for the polymerization of styrene in various solvents.

We have tested the equation for the polymerization of methyl methacrylate in various solvents, and the calculated values of C for those cases are given in the following table.

Solvent	Chain Transfer coefficient x 10^5
Benzene	0.72
Cyclohexane	0.80
Toluene	2.75
Ethyl benzene	17.00
Chlorobenzene	2.00
Chloroform	14.00
Propylene chloride	10.00
Carbontetrachloride	23.93
Dioxane	2.22
Methyl ethyl ketone	7.00
n-Butyl alcohol	3.33

With the hydrocarbons benzene and cyclohexane, the transfer constant is very small; the value increases from toluene to ethyl benzene. Chloro-benzene has got transfer constant, but in aliphatic chloro-compounds the transfer constants are extremely high, the activity increasing with increase in chlorine content. Ether (dioxane), Ketone (methyl ethyl Ketone) and alcohol (n-butyl alcohol) have got transfer constants higher than those of hydrocarbons, the ketonic compound being the most effective.

38. Solubilization of Water in Organic Solvents by Dodecylammonium Salts.

VEDANTAM VENKATESWARLU AND SANTI R. PALIT, Calcutta.

Cationic detergents of the type of dodecylamine salts are well known surface active agents and they are expected to be powerful solubilizers. A systematic study of the phenomenon of solubilization has been undertaken employing the dodecylamine salts of the fatty acid series as detergents. The solubilization studied is not of the usual type using water as the solvent but is of the reverse type, i.e., water-in-nonaqueous solvents. Preliminary experiments with dodecylamine oleate in a number of nonpolar solvents showed that the maximum amount of water is solubilized when xylene is used as the medium, and hence all subsequent experiments were done in xylene.

The usual procedure was to take 1 gm. of the solubilizer in 5 cc. of xylene and to measure the volume of water which goes in without producing any turbidity or emulsification. Using the series of fatty acids it was observed that the maximum amount of water is solubilized with dodecylamine -n-butyrate and isobutyrate and the value decreases appreciably with higher or lower homologues. The data are given in the following table:

TABLE

Solubilizer		gm. of water solubilized per gm. of detergent at 31°C.
Dodecylamine	Formate	0.07
”	Acetate	0.15
”	Propionate	0.57
”	n-Butyrate	1.84
”	iso-Butyrate	1.94
”	Valerate	0.62
”	Caproate	0.25
”	Laurate	0.18 (at 50°-60°C)
”	Palmitate	0.25 (at 50°-60°C)
”	Oleate	0.08

It was also found that the presence of either an excess of the amine or of butyric acid increases the maximum volume of water solubilized. For example, with 80 per cent excess of amine the volume of water dissolved is doubled while 20% excess butyric acid increases the volume by about 50%.

39. Limits of Supersaturation in Solutions of Solid Non-Electrolytes.

A. C. CHATTERJEE, RAM GOPAL, A. N. BOSE *and* R. P. RASTOGI, Lucknow.

Supersaturation of non-electrolytes in non-aqueous solvents has been stuided and it is shown that practical and theoretical limits are very much similar provided the internal pressure of the solvent and the solute is taken into consideration. It is pointed out that the limits of supersaturation cannot be predicated very accurately due to uncertainty in fixing up the exact values for 'r' and 'σ'.

40. Entropy of Solution, Free Energy Barrier of Nucleus Formation and the Limits of Supersaturation.

RAM GOPAL *and* R. P. RASTOGI, Lucknow.

An attempt has been made to find out whether any relationship exists between the maximum free energy barrier $F_{max.}$ $\left\{ = \frac{32\sigma^3}{H^2} \left(\frac{T_s}{T_s - T} \right)^2 \right\}$ of nucleus formation and the limits of supersaturation in a number aqueous and non-aqueous solutions. Due to the fact that the expresiion for $F_{max.}$ involves factors which are either completely unknown or known only very roughly, it is not possible to draw any definite conclusion. But some results and hypothetical intuition is definitely indicative that the $F_{max.}$ barrier can be easily surmounted at the various limits of supersaturation in different cases. Further light on the problen is expected from a study of simpler systems like melts whose supercooling is being investigated in this laboratory.

It also appears that entropy of solutions is roughly inversly proportional to the limits of supersaturation.

41. Supersaturation Limits of Solutions in Presence of Foreign Substances Part I.

A. C. CHATTERJEE *and* R. P. RASTOGI, Lucknow.

The effect of various substances on the limits of supersaturation of aqueous solution of KCl has been studied. It is found that the limit is decreased in presence of alcohol, acetone etc. It has been pointed out that the decrease in inter-facial tension is responsible for this behaviour. In the case of dyes, marked heating effect is observed. An explanation of this action has also been offered.

42. Supersaturation Limits in Non-Aqueous Solutions. Part II.

A. C. CHATTERJEE, A. N. BOSE *and* R. P. RASTOGI, Lucknow.

It has been observed that for the solutions of the same solute in different solvents, the effect of heating is different. It is suggested that solution contains particles which act as adsorbents and adsorb solute. During the process of heating these solute particles go into the solution and hence heating effect is observed. Further, for the solutions of the same solute in different solvents amount of solute adsorbed is different and hence heating effect is different. In solutions where no solute is adsorbed by the adsorbate, heating effect is not observed. A detailed paper with experimental results supporting the above view will be published elsewhere.

43. Syneresis of Sodium Oleate Gels in Mixtures of Pinene and Xylene.

MATA PRASAD *and* V. SUNDARAM, Bombay.

Sodium oleate gels were prepared in mixtures of pinene and xylene containing varying amounts of the two solvents, and the amounts of syneresis of these gels have been measured after the same time interval. The syneresis is least in pure pinene and increases to a maximum value in pure xylene. The graphs of syneresis against the composition of the mixture are S-shaped which shows that the syneresis of these gels does not obey the additivity law.

44. Effect of Area of Gel Surface Exposed on the Syneresis of Sodium Oleate Gels in Pinene.

MATA PRASAD *and* V. SUNDARAM, Bombay.

The effect of area of gel surface exposed on the syneresis of sodium oleate gels in pinene has been determined. It is observed that syneresis is directly proportional to the specific surface per unit volume of the gel provided the thickness of the gel is small. When greater thicknesses of the gel are considered, syneresis is not directly proportional to the specific surface but is slighlty higher than the value calculated on the basis of the specific surface. This difference has been attributed to the hydrostatic preassure exerted by the column of the gel.

45. Effect of Temperature on the Syneresis of Sodium Oleate Gels in Pinene

MATA PRASAD *and* V. SUNDARAM, Bombay.

The effect of temperature on the syneresis of sodium oleate gels in pinene has been studied. Increase of temperature decreases the syneresis. The relation $Y^n = Kt$ where Y is the amount of syneresis in time t and n, K are constants, holds good for temperatures above 25°C and the value of n decreases with an increases in temperature. Below 25°C, the relation does not hold. There does not seem to be any direct relationship between syneresis and temperature. But, when the graphs of syneresis against temperature for each interval of time are extrapolated, all the graphs meet the temperature axis at a single point which closely agrese with the gelation temperature ; this gives the inference that at the gelation temperature no syneresis takes place.

46. Gelation of Sodium Oleate and Sodium Stearate in Nujol.

Mata Prasad, K. B. Deshpande *and* K. P. Buch, Bombay.

Gels were prepared by dissolving different amounts of sodium olelate and sodium stearate in a definite volume of Nujol by heating to 200°C. The time of setting was determined for each gel at different rates of cooling. The results show that the time increases with slower rate of cooling for any given concentration and decreases with an increase in concentration for the same rate of cooling. It was further noted that in all cases the temperature at the time of set (i.e. the temperature of set) for any given concentration is the same irrespective of the rate of cooling, unless the cooling is too rapid or too slow.

The cooling curves of these systems during setting show breaks which extend over a range around the temperature of setting. Calculation of the heat evolved during setting shows a fair constancy of the molar heat of gelation.

47. A Study on the Supercooling of Melts of Organic Substances.

Ram Gopal *and* A. N. Bose, Lucknow.

A study of the supercooling in organic melts reveals that the difference between the melting point T_m and T, the temperature of the first spontaneous crystallisation, is almost a constant in most of the cases. In many cases *e.g.* benezophenone and 1—chloro—2:4-dinitrobenzene, melts do not crystallise at all unless inocculated.

Calculations of F_{max}, the maximum free energy barrier for the nucleus formation, reveal that it falls into two categories, although at persent no definite conclusion can be drawn.

48. Polymerization in the Solubilized State.

Ranajit Sengupta *and* Santi R. Palit, Calcutta.

Styrene has only limited solubility in propylene glycol near room temperature but they are completely miscible with additiion of enough soap, *e.g.*, sodium oleate. We have studied the polymerization of styrene thus solubilized in propylene glycol using ammonium persulphate as catalyst. This study is of evident interest in connection with the mechanism of emulsion polymerization.

We have found that the system has a high oxygen sensitivity, the reaction being inhibited by traces of oxygen. Speed of the polymerization process is fairly high (about 2.6% per hour with 0.1 mol per cent of the catalyst at 40°C.). Further a small variation in the soap concentration does not change the speed to a marked degree.

The results indicate that there is no essential difference between the catalysed polymerization in homogeneous solution, the polymerization in solublized state and the emulsion polymerization.

49. Ferric Oleate as Catalyst in Vinyl Polymerization.

Jyotirindra Nath Sen *and* Santi R. Palit, Calcutta.

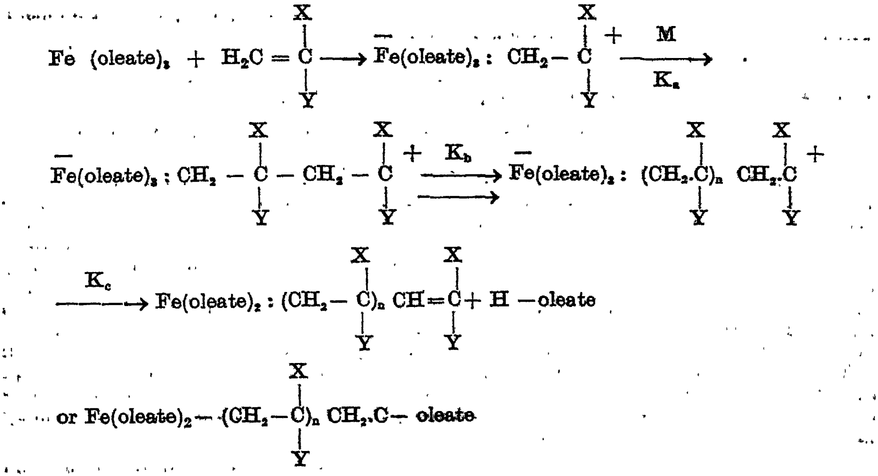
It was observed in an earlier work from this laboratory that the presence of ferric oleate tends to increase the speed of peroxide-catalysed polymerization of styrene in solution. It occurred to us that the above conditions are very unfavourable for studying the effect of ferric oleate itself, as the high catalyst concentration and low concentration of the monomer might mask the effect. Hence, the effect of ferric oleate on the uncatalysed polymerization in bulk as also in stronger solution has been studied and the work has been extended to methyl methacrylate. Our expectation was confirmed and it was found that ferric oleate is a fairly strong catalyst for the above polymerizations, the catalytic power being enough to produce pereceptible polymerization of styrene or methyl methacrylate in bulk even at room temperature in less than a day.

Experiments were conducted with 0.2 weight per cent ferric oleate (approximately, 1 mol. ferric oleate per 4,500 mol monomer) for bulk polymerization in vacuum of styrene and methyl methacrylate at 35°C and 80°C. Reckoning from the initial slope of the yield curve, the catalytic effect is found to increase the speed for styrene polymerization from an yield of 0.6 to 1.63 per cent per hour at 80°, and from 0.2 to 5.75 per cent per day at 35°C ; for methyl methacrylate the uncatalysed yield of polymer is 1.08 per cent per hour at 80° whereas the presence of ferric oleate produces 2.34 per cent per hour at the same temperture. The intrinsic viscosity of the catalysed and the uncatalysed polymers was determined. Some illustrative data are as follows :

TABLE

Polymethyl methacrylate (80°C).	[η] Benzene	Molecular weight.
Uncatalysed	4.05	17.8×10^5
Catalysed	2.2	7.96×10^5
Polystyrene (80°C).		
Uncatalysed	2.35	9.74×10^5
Catalysed	1.90	5.81×10^5

It is further observed that the polymer contains iron, and the amount of iron is higher if prepared at a lower temperature. This iron is difficult to remove by the usual method or even by treatment with acid. Hence it is concluded that this iron is bound with the polymer molecule which leads us to believe that this is a case of polar polymerization probably by the followig mechanism :



$$\mathrm{Fe\ (oleate)_3} + \mathrm{H_2C} = \overset{\overset{X}{|}}{\underset{\underset{Y}{|}}{C}} \longrightarrow \overset{-}{\mathrm{Fe}}\mathrm{(oleate)_3} : \mathrm{CH_2}-\overset{\overset{X}{|}}{\underset{\underset{Y}{|}}{C}}{}^{+} \xrightarrow[K_a]{M}$$

$$\overset{-}{\mathrm{Fe}}\mathrm{(oleate)_3} : \mathrm{CH_2} - \overset{\overset{X}{|}}{\underset{\underset{Y}{|}}{C}} - \mathrm{CH_2} - \overset{\overset{X}{|}}{\underset{\underset{Y}{|}}{C}}{}^{+} \overset{K_b}{\underset{\longrightarrow}{\longrightarrow}} \overset{-}{\mathrm{Fe}}\mathrm{(oleate)_3} : (\mathrm{CH_2}.\overset{\overset{X}{|}}{\underset{\underset{Y}{|}}{C}})_n\ \mathrm{CH_2}.\overset{\overset{X}{|}}{\underset{\underset{Y}{|}}{C}}{}^{+}$$

$$\xrightarrow{K_c} \mathrm{Fe(oleate)_2} : (\mathrm{CH_2}-\overset{\overset{X}{|}}{\underset{\underset{Y}{|}}{C}})_n\ \mathrm{CH}=\overset{\overset{X}{|}}{\underset{\underset{Y}{|}}{C}} + \mathrm{H-oleate}$$

$$\text{or } \mathrm{Fe(oleate)_2} - (\mathrm{CH_2}-\overset{\overset{X}{|}}{\underset{\underset{Y}{|}}{C}})_n\ \mathrm{CH_2.C} - \mathrm{oleate}$$

Unlike usual type of polar polymerization as brought about by BF_3, $SnCl_4$, $TiCl_4$ etc., Ferric oleate initiates the polymerization at room temperature at a convenient rate and produces a polymer of fairly high molecuar weight and so this system is more easily studied and promises to enrich our knowledge about this type of polymerization.

Further experiments are in progress to know more details of the process and test the above hypothesis.

50. Retardation of Polymerization of Styrene and Methyl Methacrylate by Metallic Soaps.

JYOTIRINDRA NATH SEN *and* SANTI R. PALIT, Calcutta.

We have observed in a previous paper (communicated for publication to Indian Chemical Society) that some metallic soaps retard polymerization. We have continued the work with the oleates of various metals, viz., chromium, silver, cadmium, lead, copper and also a few surface active agents souch as glycerol monostearate, triton N-100, aerosol OS and cetavlon. We have observed that all these substances retard polymerization whether the polymerization is thermal or peroxide catalysed, the monomer being either in bulk or in solution. The catalysed polymerization is found to be less retarded than the uncatalysed.

The retardation in the case of almost all the above compounds is small except in the cases of copper oleate and cetavlon where a strong retardation and sometimes complete inhibition takes place, We have carefully studied the inhibitory effect of copper oleate, all polymerization experiments being run in vacuo. The strong inhibition can be judged from the following typical example : 12 per cent solution of styrene in benzene at 80°C is polymerized to the extent of 9.5 per cent in 120 hours, but the presence of copper oleate to the extent of 0.01 per pent (one mol copper oleate per 7,000 mols styrene) inhibits the polymerization completely upto the same period under identical conditions. In the case of methylmethacrylate in bulk, at 80°, polymerization after a period of 22 hours was 33.6 per cent for the unretarded reaction and only 2.7 percent with 0.2 per cent added copper oleate.

In polymerization of styrene in benzene solution there is an apporoximate proportionality between the inhibition period and the concentration of copper oleate. This agrees with the previlousy observed behaviour of most inhibitors in bulk or in solution. However, this proportionality breaks down at lower concentration of copper oleate. In fact on closer study it is found out that as we go on decreasing the concentration of copper oleate the retardation slowly disappears and in sufficiently dilute solution acceleration is observed. For example, it is found that even 1.5 moles of copper oleate per one million moles of styrene perceptibly acclerate the polymerization of styrene in solution (1.15 molar). These experiments have been repeated and the results confirmed.

It is suggested that the cupric oleate is reduced to cuprous oleate as it exercises its inhibitory activity just as quinone is reduced to hydroquinone, and the cuprous oleate porduced by the reduction acts as the accelerator, probably by polar mechanism. Further work is in progress to test this mechanism.

51. Physico-Chemical Properties of Carboxyethyl Cellulose.

PARES CHANDRA DAS GUPTA *and* SADHAN BASU, Calcutta.

An investigation of the properties of carboxy-ethyl cellulose and its sodium salt has been undertaken with a view to finding out its industrial uses like carboxy methyl cellulose. Preparation of the compound is much easier and the yield is also considerably higher than carboxy methyl cellulose. The preparation has been done from various cellulose, viz., filter-paper, adsorbent cotton (B.C.P.W.) and Doria cotton from Bombay by treating the sodio cellulose with equimolecular proportion of acrylo-nitrile in benzene and then hydrolysing the cyano compound with concentrated NaOH. The acid was isolated from the sodio salt by treating it with concentracted mineral acid. The extent of substitution was determined by electrometrically titrating the free acid with alkali using a glass electrode and a Beckman pH meter. The extent of substitution was in all cases about 0.28. The dissociation constant of the free acid was about 2.24×10^{-6} calculated from the pH at half-neutralisation point, much less than that of carboxy methyl cellulose. ($K_a = 5.1 \times 10^{-5}$)

The sodium salt of the acid was soluble in water, mere so in a solution of sodium hydroxide but is precipitated from water with alcohol. On increasing the pH of the solution the viscosity of the aqueous solution of sodium salt falls rapidly at higher pH, but does not increase again on diminishing the pH. This is due to better dispersion of sodio-salt in alkali whereby free OH groups become highly solvated and thus do not agglomerate on neutralising the NaOH with acid.

Similarly on heating the solution of sodio-salt the viscosity falls which does not revert back to original value on cooling, the cause of which may be sought for in the same phenomenon, viz., better dispersion of the salt in water at higher temperature.

52. A New Method of Measuring Permeabilities of Oilsands.

N. C. SEN GUPTA, Digboi.

In the usual method of measuring permeabilities e.g. of oilsands, air at a constant pressure is passed through the specimen of known dimensions and the volume rate of flow is noted. Knowing the inlet and outlet pressures of air and its viscosity the permeability is calculated from Darcy's law. This method requires a steady supply of air at constant pressure and an accurate gas-meter. These may not be always avail able. In the method developed by the author air is pumped with an ordianry hand-pump into a glass bottle fitted with a manometer until a pressure some what above 0.5 atmosphere is obtained. The air is then allowed to flow through the specimen and the time required for the pressure to fall from e.g. 0.5 to 0.25 atmosphere is noted. The mean pressure can be obtained graphically to calculated the constant of the equation K = Const./*t*. An equation connecting permeability (K) with the initial and final pressures has also been derived :

$$K \quad \frac{\eta \; L \; V \ln \left(\frac{\Delta p_o}{\Delta p_t} \cdot \frac{2 \times \Delta p_t}{2 \times \Delta p_o} \right)}{t. \; A}$$

where η is the viscosity of air ; L, length of the cylindrical sample of cross-section A ; V, volume of the bottle ; $\Delta\ p_0$, initial and $\Delta\ p_t$, final pressure of air in the bottle.

Results obtained by the new method agree closely with those obtained by the usual method.

53. Studies in Glass Systems—Refractometric Measurements of the System-Platinum-Lindemann Glass.

Subodh Kumar Majumdar, Darjeeling.

The present work is an extension of the various papers published by the author on different glass systems, containing various polar crystals and noble metals. The present paper records the results obtained with the system Platinum dispersed in Lindemann glass.

Different samples of the glass were prepared by heating Lindemann glass and finely divided platinum obtained by first evaporating an aqueous solution of platinic chloride and then by strongly heating it in a platinum crucible. The platinum-contents of the samples were determined by reducing the platinum in solution by stannous chloride and matching with a standard solution in a Colorimeter.

The refractive index was determined by Becke method backed by a Pulfrich Refractometer. The densities were determined by a modified Floatation method (Majumdar and Sarma, J. Indian Chem. Soc., 1942, *19*, 241).

The results show a very interesting deviation from the other cases studied by the author. While in every other case, the specific refraction of the dispersed phase has been found to be smaller than the corresponding value in the pure state, in the present case, the reverse phenomenon has been noticed. The specific refraction of the platinum dispersed in Lindemann glass is found to be actually higher than that of the pure metal.

The magnetic susceptibility measurements of similar systems also reveal increased values of diamagnetic susceptibility of the dispersed phase. The magnetic and refractometric results are discussed. Magnetic measurements indicate an enlargement of the lattice i.e. increase of orbits of the loosely bound electrons in the metallic lattice. In the case of platinum only, refractometric measurements reveal higher values of mole refraction, supporting the magnetic data. In all other cases, studied so far, the magnetic and refractometric data run counter to each other. The subject has therefore great theoretical interest.

54. Colloid Chemistry of Metal Hydroxides. I. Alumina Gels.

B. P. Gyani, Patna.

Some indications of conditions have been found out under which a hard, transparent, and granular gel can be prepared. It is found that the ageing of the precipitated alumina at room temperature particularly in presence of large quantities of soluble salts leads to soft, chalky gels. Hard, fairly transparent gels may be prepared by precipitation from boiling solutions and immediate washing. The deterioration of the hydroxide may be prevented by the addition of small quantities of acetic acid.

55. Effect of Non-Electrolytes on the Antagonism of Ions in Coagulation of Sols.

L. POCHHALI *and* S. N. MUKHERJEE, Jadavpur.

Antagonism between different monovalent and divalent and monovalent and trivalent ions was studied with reference to the coagulation of Arsenious sulphide sol both in presence and absence of non-electrolytes. While no antagonism was observed between ions of same valency, that between monovalent and divalent ions was the most prominent. The most significant antagonism was observed in the KCl-BaCl$_2$ pair.

Of the effect of non-electrolytes on ionic antagonism area presents no appreciable difference from that of water, so far as KCl-BaCl$_2$ pair is concerned. The antagonism is very prominent in ethyl alcohol and runs in the order ethyl alcohol $>$ methyl alcohol $>$ cane sugar $>$ urea, water. In general the antagonism is maximum when the concentration of KCl is near about 50% of its own coagulating concentration.

56. Optical Properties of Zirconium Hydroxide Gels.

MATA PRASAD *and* K. E. S. MANI, Bombay.

Changes in the opacity and the depolarisation factors (ʃ*u*, ʃ*v* and ʃ*h*) of light scattered transversely by zirconium hydroxide gels were measured at suitable intervals during gelation. The results indicate that the initial slight anisotropy of the particles decreases at the early stage of gelation but later on increases continuously throughout the course of gelation. There is also a gradual increase in the size of the particles during gelation, the ultimate size being smaller than the wave-length of light. These observations indicate that the process of gelation of zirconium hydroxide is similar to that of coagulation.

The addition of small quantities of HCl, HNO$_3$ or H$_2$ SO$_4$ does not modify the course of gelation, but HCI and HNO$_3$ inhibit the agglomeration of the colloidal particles; increasing concentration of the acids further retards agglomeration. The size, anisotropy and the number of gelling particles appear to be smaller in the presence of these acids. The addition of small quantity of sulphuric acid inhibits agglomeration, but larger amount increases it.

57. Optical Properties of Thorium Molybdate Gels.

MATA PRASAD *and* K. E. S. MANI, Bombay.

The changes in opacity and the depolarisation factors (ʃ*u*, ʃ*v* and ʃ*h*) of the light scattered transversely by thorium molybdate gels during gelation were determined at suitable intervals. The results indicate that the colloidal solution of thorium molybdate consists of small fairly anisotropic particles at the initial stage. During gelation, the particles continuously increase in size but decrease in anisotropy until they attain a constant size (smaller than the wave-length of light) and become nearly isotropic in structure. The opacity of the gels decreases continuously during gelation and the process of gelation is similar to that of coagulation.

The addition of small quantities of the acids to these gels does not modify the course of gelation. The acids peptise the colloidal aggregates of thorium molybdate, and hence the initial and the final sizes and the anisotropy of the particles in gels containing acids are smaller than those of particles in gels prepared without the addition of acids. The peptising effect becomes greater, the larger the quantity of the acid added. The final values of opacity for gels containing acids indicate the possibility of acids dissolving some of the colloidal matter. Further, the solvent action of the acids in such gels becomes more pronounced with larger amount of the acid.

58. Effect of Irradiation on the Absorption of Anthracene Solution in Benzene.

(MISS) K. K. ROHATGI *and* S. N. MUKHERJEE, Jadavpur.

In continuation of the work reported last year on the effect of irradiation on a solution of anthracene in benzene containing varying quantities of CCl$_4$, spectrophotometric study of such irradiated solutions was persued. Absorptions of the solutions irradiated at 3650 A° for varying durations were studied, in the range of 2200 A°—5000 A° against non-irradiated solutions of the corresponding concentrations.

From the nature of the absorption curves, it appears that the absorption of anthracene is considerably changed by these irradiations. On keeping these irradiated solutions in the dark, although absorption increases but the curve does not exactly simulate that of anthracene.

59. Dipole Moments of Metallic Soaps.

BIRENDRA CHANDRA BANERJEE *and* SANTI R. PALIT, Calcutta.

The dipole moments of seven metallic soaps, viz., the oleates of Mg, Ca, Zn, Cd, Pb, Cu and Ni, have been determined by a heterodyne beat method. The values are 4.97 D, 5.01 D, 0.82 D, 3.2 D, 3.2 D, 1.68 D and 4.10 D respectively.

Though the metallic soaps are generally regarded as nonpolar from their physico-chemical, particularly, solubility behaviour, being completely soluble in organic solvents, these data show them to be fairly highly polar. It is suggested that this high polarity is caused not by high charge but by a comparatively large separation between the charges owing to the centre of negative charge residing well within the hydrocarbon radical of the oleates. This shifting of the centre of negative charge from the — COO^- end to the adjacent hydrocarbon radical is supposed to be caused by an inductive effect due to the repulsion experienced by the bonding electron pair of the $\overrightarrow{C:H}$ bond from the negative charge which causes all C-H bonds to the polarised, the nearer C-H bonds being polarised more than the distant bonds.

It is further observed from an examination of the μ-values of the group II elements, Mg, Ca, Zn, and Cd oleates that the order of their dipole moments is opposite to the order of their ionisation potentials.

Calculation of μ-values has also been made according to a new equation developed by Jatkar, Sathe and Iyengar based on Debye's method of treatment with a few quantum restrictions as to the orientation of the dipoles in the electric field. It is found that μ-(Jatkar et al.) is always lower than μ(Debye). It is further observed that P_2 (total polarization) is strongly dependent on concentration both in the new and in the classical Debye equation and so the new equation does not offer any advantage over the Debye equation in these cases.

60. Bromination of Sodium Acetate in Glacial Acetic Acid Medium.

MIHIR NATH DAS *and* SANTI R. PALIT, Calcutta.

It was reported earlier (Das, Science & Culture, *14*, 165, 1948; Das and Palit, J.I.C.S., July 1949) that bromine readily reacts with sodium acetate dissolved in glacial acetic acid. From a kinetic study it has been found that the reaction is a bimolecular one and can be represented as follows:

$$CH_3\ CO.\bar{O} + Br_2 = CH_2Br.\ CO.\bar{O} + H^+ + Br \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$CH_3\ CO.\bar{O} + H^+ = CH_3\ CO.OH$$

The second step of the reaction is obviously an instantaneous process, so that the first step is the rate determining factor. In order to minimise the complications involved due to tri-bromide formation, the reaction was carried out in presence of excess bromide, for it can be shown that under these conditions, free bromine at any stage of the reaction is a constant fraction of the total titratable bromine. If *a* and *b* denote the initial molar concentrations of bromine and acetate respectively, the kinetic equation can be represented by $\frac{dx}{dt} = k\ (b-2x)\ (a-x)\ \alpha$, where α is a constant for the particular bromide and bromine concentrations used. The experimental results were found to be in excellent agreement with this equation. The values αk_2 were obtained graphically, from which the bimolecular constant k_2 was calculated. Using various bromide concentrations ranging from 0.09 to 0.26 M, the values of k_2 were found to lie in the range 1.85—2.26 litre gm./mole min^{-1} at 35°C. The divergence in the values is possibly due to variable amounts of water likely to be associated with different samples of acetic acid used in different sets of experiments, for water strongly accelerates the reaction. Using a highly purified sample of acetic acid, the values of k_2 at several bromide concentrations from 0.109—0.168 M were found to lie in the range 1.85—1.94, the mean value being 1.90 litre gm./mole min^{-1} at 35°C. From the temperature coefficient of the reaction, the activation energy is found to be of the order of 15.6 K. cals/mole.

Water strongly accelerates the reaction. In aqueous acetic acid containing 20% water the reaction is still bimolecular the speed being several times higher than in glacial acetic acid medium. But with higher proportions of water, the bi-molecular nature of the reaction is no longer evident. It is very interesting to note that in pure water, i.e., water containing no acetic acid, practically no reaction occurs.

Using different alkali acetates, the speed of the reaction is found to lie in the order K > Na > Li.

As regards the mechanism of the reaction, it may be suggested that, bromine being an electrophilic reagent in substitution reactions, the bromination of the acetate ion occurs due to an increased electron density at the α-carbon atom, resulting from an operation of the +I effect of the negatively charged oxygen at the carboxylate end.

61. Catalytic Decomposition of Potassium Chlorate in the Pressence of of Molybdic Acid, Chloroauric Acid and Chloro-Platinic Acid.

G. B. KOLHATKAR *and* L. M. APTE, Sangli.

The mixtures of Molybdic acid, Chloroauric acid and Chloroplatinic acid and of Potassium Chlorate, in the proportion of 1 to 10 are heated at suitable temperatures and the decomposition of Potassium Chlorate is studied as a time reaction by measuring the Oxygen evolved at definite intervals of time. With Molybdic acid and Chloroauric acid, the temperature required to start the decomposition is in the neighbourhood of 275°, while with Chloroplatinic acid it is much higher.

62. Variation of Relative Viscosity with Temperature (Non-Aqueous Solutions of Electrolytes and Non-Electrolytes).

A. C. CHATTERJEE *and* A. N. BOSE, Lucknow.

The variation of relative viscosity with temperature has been studied. It has been observed that the value of $\frac{S}{\delta t}\left(\frac{\eta_s}{\eta_s}\right)$ is negative for all the solutions studied here.

63. Viscosity of Unimolecular Surface Films.

A. K. MUKHERJEE *and* S. N. MUKHERJEE, Jadavpur.

Boyd and Harkin's empirical equation relating surface viscosity of unimolecular films and the surface pressure has been deduced theoretically by a thermodynamic treatment from the fluidity equation as deduced above.

64. Relation Between Viscosity of Liquids and Temperature.

A. K. MUKHERJEE *and* S. N. MUKHERJEE, Jadavpur.

A new relation between viscosity of liquids with temperature has been deduced theoretically through the partition function of a molecule in the liquid state. The equation has been tested for a large number of normal liquids and has been found to be in better agreement with facts than the long established equation :

$$\log \eta = A + \frac{B}{T}$$

No mechanism of viscous flow has been assumed in the theoretical treatment.

65. Kelly Tube for Sedimentation Analysis.

V. V. Deshpande *and* M. S. Telang, Nagpur.

Some authors have given an elaborate calculation of the correction factor to be included in the original Kelly equation (Ind. Eng. Chem., *16*, 928, 1924) to account for the progressive increase in the liquid level in the settling tube due to the recession of the liquid from the capillary side-arm. The present paper describes a practical device for maintaining the liquid level in the settling tube constant so as to retain the validity of the original Kelly equation. Furthermore, ordinary methods of measuring the angle of inclination of the capillary side-arm of Kelly tube in the working position of the apparatus after placing it in a thermostatic bath may lead to considerable and uncertain errors. This fact has been one of the major drawbacks of Kelly's apparatus. The constant-level device is further useful in the precision determination of the angle of inclination of the capillary side-arm.

66. Adsorption of Neutral Red on Metal Surfaces.

K. K. Dole *and* B. W. Kelkar, Poona.

Neutral red is adsorbed in multilayers on pure copper plates, copper plates thickly coated with mercury, and iron plates deposited with copper. During the adsorption of neutral red some needle like substance is separated, which is insoluble in water but soluble in benezene to a yellow coloured solution. This indicates orientation of molecules during the course of adsorption. Addition of acetic acid to the dye solution slightly *increases the adsorbtion coefficient while addition of small amounts of sodium* hydroxide increases the coefficient to a great extent. It indicates that there is a pH which will give maximum adsorption. The adsorption on copper is twice that on the mercury plates. Further work on the relation of pH to adsorption is in progress.

67. Adsorption of Methyl Orange on Metal Surfaces.

K. K. Dole *and* B. W. Kelkar, Poona.

Pure copper plates, iron plates with an uniform deposited layer of copper and thickly mercury-coated copper plates have been used for the studies of adsorption of dyes on metallic surfaces. Deposited copper adsorbs dyes very strongly, perhaps the specific surface available for adsorption is larger than in the case of copper plates. Multilayer adsorption is observed in both pure copper plates and the mercury coated copper plates. Addition of small quantities of acids and alkalis has a great influence on the adsorption, thus sodium hydroxide, acetic acid and sodium chloride inhibit the process of adsorption, while sodium acetate and sodium bicarbonate are seen to increase the adsorption. However, sodium carbonate suppresses the adsorption indicating that there is a definite range of pH for maximum adsorption. Coefficient of adsorption of copper plates is about 2.5 times greater than the mercury coated plates.

68. Adsorption of Dyes on Mercury Surfaces.

K. K. Dole *and* B. W. Kelkar, Poona.

Adsorption of several dyes on copper plates thickly mercury coated is studied in the present investigation. Several interesting features have been observed, the most important being the multilayer adsorption of dyes. The adsorption coefficient of dyes depends upon the constitution of the dyes and orientation of the dye molecules on the mercury surface. The adsorption coefficient increases in the following order: sodium indigo sulphonate, methyl violet, crystal violet, Bismark brown, methyl green, methylene blue, methyl orange. In addition to oriented adsorption, selective adsorption seems to take place. Change of colour of the dye also takes place in many dyes and this has been attributed to oriented adsorption. But in the cases of aniline blue, neutral red and congo red colour change varies according to the extent of adsorption. The cause of this latter change is yet to be elucidated and further work in this direction is in progress. Influence of change of pH on the adsorption of dyes has also been studied and is found to be dependent on the nature of the dye. Adsorption of methyl orange is completly supressed in alcoholic solution, while that of neutral red is increased. Similarly, congo red is not adsorbed in alcholic solution. Further work about the influence of addition of foreign substances is in progress.

Organic Chemistry

69. Chemical Investigation of Indigenous Medicinal Plants.—Part I. Achyranthes Aspera.

V. J. DALVI *and* R. C. SHAH, Bombay.

Achyranthes aspera (N.O. *Amarantaceæ*) possesses valuable medicinal properties as a pungent laxative and is considered useful in dropsy, piles, boils, eruptions of the skin etc. Dymock, Warden and Hooper (Pharmacographia Indica, Vol. III, p. 135) have carried out the ash determination of the leaves, stems and roots and examined the ash contents, but they have not been able to isolate any definite constituent from the plant material.

In the present investigation the stems dried at 100°C gave 8.578% ash. A qualitative analysis of the ash inicated the presence of Fe'', Al'', Ca'', K', Na' and SO_4'', CO_3'' Cl', PO_4'''.

The air dried stems of the plant on extraction with pertroleum ether yielded a colourless crystalline compound giving colour reactions for phytosterols. An examination of the hydrochloric acid extract indicates the presence of an alkaloid. Further investigation is in progress.

70. Chemical Examination of Enhydra fluctuans Lour.

R. N. CHAKRAVARTI *and* A. DUTTA, Calcutta.

Enhydra fluctuans (N.O. Compositæ) is a marsh herb common in Bengal and Assam. Its leaves are slightly bitter and are used as a cure for inflammations, leucoderma, bronchitis, skin diseases, neuralgia ane other nervous diseases and in torpidity of liver.

Moisture content of the plant was found to be over 90%. Preliminary examination revealed the existence of a trace of an alkaloid. Systematic examination of the dry plant gave 0.021 per cent of an essential oil, 4.7 per cent of a non-volatile non-saponifiable matter and a minute quantity of a bitter substance soluble in hydroxylic solvents. The non-saponifiable fraction on crystallisation and chromatography gave 7.5 per cent of stigmasterol, m.p. 167°, which gave an acetate m.p. 144° and a benzoate m.p. 160°(mixed m.p. with authentic specimens compared). No other sterols could be isolated in a state of purity. The existence of stigmasterol as the chief constituent in the sterol fraction of this particular plant is noteworthy in view of the general belief that stigmasterol occurs in plants almost always associated with much larger quantities of α-, β-, γ-sitosterols and other phytosterols.

Quantitative determination of inorganic constituents of the plant was also carried out. Further work is in progress.

71. Chemical Investigation of Holbaelia Latifola: Isolation of a Glucoside.

D. CHAKRAVARTI *and* ASOKA KUMAR MITRA, Calcutta.

From the alcoholic extract of the stem of *Holbœlia Latifolia* (Nep.—Gophla) a glucoside m.p. 233°-235° (decomp) has been obtainted which is found to be haemolytic and poisonous to fishes. It has been hydrolysed and the sugar has been identified as galactose by the formation of the osazone. The aglucone (m.p. 295°-300°), decomp) is obtained as needles. (Found : C, 76.21%, H, 10.11%). It forms acetyl (m.p.163°-165°) and methoxyl (m.p. 223°-224°) derivatives.

72. On the Formation of 2 : 4-Bis-diazophenol.

D. P. BURMA *and* B. BANERJEE, Calcutta.

2,4 Bis-diazophenol is always formed in minute traces when p-hydroxyazobenzene is prepared by coupling of one molecule of diazonium chloride with one molecule of sodium phenolate. 2,4 Bis-diazophenol accompanies p-hydroxyazobenzene as a dark tarry product which separates out first from alcoholic solution. So far our knowledge goes, no where in the literature this has been previously mentioned.

73. Synthesis of Bridged-Ring System.

NRIPENDRA NATH CHATTERJEE, Calcutta.

Ethyl Δ^1—tetrahydrobenzoate is condensed with ethyl sodiocyanacetate, and the resulting sodio-derivative is allowed to react with ethyl bromoacetate when ethyl 1-carbethoxy cyclohexane-2-cyanosuccinate (b.p. 204°–206°/4 mm) is obtained. This on hydrolysis by means of sulphuric acid (20%) gives a very good yield of 1-carboxycyclohexane-2-succinic acid. The gummy acid is esterified when a quantitative yield of the triester (b.p.177°-185°/7mm.) is obtained. The ester is cyclised with granulated sodium to yield ethyl (0:3:4-bi-cyclo)-nonan-2-one 3:4-dicarboxylate (b.p. 188°/8 mm.). It gives violet coloration in alcoholic solution with ferric chloride and when hydrolysed by means of sulphuric acid gives (0:3:4-bicyclo)-nonan-2-one-4-carboxylic acid (m.p. 136°C)which possesses all the properties of a keto-acid and on esterification furnishes the required keto-ester (143°-44°/8 mm.) in a quantitative yield. This keto ester is allowed to react with ethyl-bromo-acetate in presence of zinc wool when a product is obtained which seems to be a mixture of the unsaturated esters and diethyl (0:3:4-bicyclo)-nonan-2-hydroxy-2-acetate-4-carboxylate. This on dehydration and catalytic reduction gives ethyl (0:3:4-bicyclo)-nonan-2-acetate-4-carboxylate (b.p. 165°-70°/6) mm.).On hydrolysis by means of alcoholic potash the above ester gives (0:3:4-bicyclo)-nonan-4-carboxylic-2-acetic acid. This is treated with acetic anhydride and distilled in vacuum when 1:4-endomethylene decahydronaphthalene-2-one (b.p. 105°-10°/9 mm.) is obtained. 1:4-Endomethylene decahydronaphthalene (b.p.78°-80°/11 mm.) is obtained by Clemmensen reduction of the ketone.

74. Studies in the Diphenyl Series.

I. K. KACKER *and* S. H. ZAHEER, Hyderabad-Dn.

During the course of study in the preparation of substituted phenanthrenes starting from 2- substituted diphenyls, 2-amino-3:5-dinitro-diphenyl, prepared by the method of Bradsher and Amore (J.A.C.S., 1944, *66*, 1283), was diazotised with nitrosyl-sulphuric acid in acetic acid and subsequently treated, in cold, with a solution of potassium nickelocyanide, with regular additions of sodium carbonate to keep the solution neutral. The 2-cyano-3:5- dinitro-diphenyl formed was isolated in the usual manner and crystallised from acetone-methyl alcohol giving a yellow crystalline substance melting at 244-45°. The nitrile, so obtained, on hydrolysis with 70% sulphuric acid at 140° for 4 hours and subsequent usual isolation treament did not give an acid (insoluble in Na_2CO_3) but the amide, crystallizing from methyl alcohol as a light yellow crystalline substance m.p. 214-15°C.

75. Studies in the Oxidation of Indigo for the Preparation of Isatin.

S. K. SAHA, Calcutta.

Oxidation of Indigo, both synthetic and natural, by means of Sodium Dichromate and various acids and under varying conditions has been studied. Best yield of Isatin has been obtained by oxidising Indigo with dilute Sulphuric Acid and dichromate mixture at the optimum temperature of 45°C.

From the point of view of industry, it is advisable to prepare Isatin by oxidising synthetic Indigo or Indigo containing more than 90 per cent of Indigotin, which gives almost the theoretical yield of Isatin by the sulphuric acid method. Natural Indigo is uneconomic for tho purpose.

76. On Certain Keto-Sulphones.

U. P. BASU *and* A. K SEN, Calcutta.

4-Amino-benzene-sulphinic acid is being condensed with alpha-beta unsaturated ketones obtained by reacting salicylaldehyde or cinnamic aldehyde with suitable ketones. The above acid also condenses with Coumarin derivatives to give rise to Sulpho-coumarin derivatives. Their characteristics are being studied for evaluating their efficacy against acid-fast organisms.

77. Schiff's Bases from Diamino Diphenyl Sulfone.

U. P. Basu *and* K. R. Chandran, Calcutta.

4:4′-Diamino diphenyl sulphone is known to have powerful antibacterial properties, but is somewhat toxic. Its several derivatives are now being advantageously used in the treatment of leprosy and even pulmonary tuberculosis. As the biological reaction of the drug is often believed to be due to the presence of one amino grouping (*cf.* Smith *et al*, Proc. Soc. Expt. Biol. Med., 1947, *64*, 261), Schiff's bases from 4:4-diamino diphenyl sulphone with unsymmetrical grouping are being considered to be of interest.

Accordingly, several 4:4′-derivatives such as salicylidene-cinnamylidene, benzylidene-cinnamylidene, disalicylidene, salicylidene-ethylidene, acetyl-cinnamylidene and acetyl-salicylidene—of diamino diphenyl sulphones have been prepared.

78. Certain Derivatives of 4-Amino Diphenyl Sulphones.

U. P. Basu *and* K. R. Chandran, Calcutta.

The sulfa drug action is being believed to be brought about by combination of the drug through its basic amino group with some enzyme systems of the organism (*cf.*, Klotz, *J. Amer. Chem. Soc.*, 1944, *66*, 459), and it is in this reaction that it displaces p-aminobenzoic acid from an active centre in an enzymic surface or compete with it for the formation of enzyme complex. As such it may be of interest to synthesise some mono-amino-diphenyl sulphone (*cf.* Bauer, *J. Amer. chem. Soc.*, 1948, *70*, 2254) derivatives in order to find a product that may easily form an enzyme-drug complex at the site of infection.

With this end in view derivatives of 2:5-dihydroxy-4-amino diphenyl sulphones and 2:4 dinitro-4-amino-diphenyl sulphones have been prepared from benzaldehyde and cinnamic aldehyde. The activity of these compounds are being studied.

79. A New Method for the Preparation of 4:4′-dinitro-diphenylsulphide and a Modification in the Process for the Reduction of 4:4′-dinitro-diphenyl Sulphone.

H. G. Biswas, Calcutta.

A new method for the preparation of 4:4′-dinitrodiphenyl-sulphide, which forms the starting material for the preparation of 4:4′-diaminodiphenyl sulphone, the mother substance of the well-known anti-leprosy drugs Diasone and Sulphetrone has been described. A modification in the process for the reduction of 4:4′-dinitrodiphenyl sulphone into 4:4′-diaminodiphenyl-sulphone has also been given

80. Chemotherapeutic Studies on Organo—Antimony Compounds.

S. J. Das Gupta, Calcutta.

Now-a-days sodium antimony gluconate in aqueous solution is much used in Kala-azar (leishmaniasis). This product has the following advantages over Urea-stibamine and other antimonials :—

(1) Its toxicity is much lower and reactions are fewer.

(2) It can be administered by any parenteral route.

(3) Its aqueous solution can be kept for a long period without any chemical or pharmacological change.

As the methods of preparation of the above antimony compound as found in literature are lacking in experimental details, a detailed as well as economic process for preparing this antimonial has been worked out and described in this paper. Pure antimony trioxide was oxidised with iodine to antimony pentoxide which was converted to antimonic acid and reacted with calcium gluconate. Calcium was removed by adding sulphuric acid and the resulting acid was neutralised with caustic soda when a solution of sodium antimony gluconate was obtained which was evaporated on steam bath for proper concentration. This solution has remained stable for over a year and found suitable for both intravenous and intramuscular injection.

81. Synthesis of Diamidines containing Arsenious Acid Group.

T. N. Ghosh, Calcutta.

In order to ascertain whether the presence of both arsenic and amidino groups in one molecule will stimulate, or suppress, trypanocidal activity, some diamidines containing arsenious acid group have now been synthesised for pharmacological examination. *p*-Cyanoacetanilide or *p*-Cyanobenzanilide has been condensed with *p*-arsanilic acid in presence of phosphorus oxychloride to yield N-alkylated amidines, containing arsenious acid as well as cyano groups. These compounds have readily furnished the arsenious acid derivatives containing an unsubstituted and a substituted amidino groups, *via* the corresponding imino-ether hydrochlorides obtained in excellent yields in presence of nitrobenzene. These diamidines readily respond to the specific colour reaction as discovered by Fuller (*Nature*, 1944, *154*, 773) for unsubstituted aromatic amidines.

82. On the Synthesis of Diamidines and Triamidines.

T. N. Ghosh, Calcutta.

In recent years some diamidines have been found to display high bacteriostatic activity against gram-positive and gram-negative bacteria and appear to be promising antibacterial agents suitable for use in surface infections (Thrower and Valentine, *Lancet*, 1943, 133 ; Wien *et al.*,*ibid.*, 1948, 771). In view of these interesting observations, it has been considered desirable to synthesis some diamidines and triamidines (each containing a substituted amidino group) and study their antibacterial properties.

Acetanilide has been condensed with *p*-cyanoaniline in presence of $POCl_3$ to yield (phenyl)-(*p*-cyanophenyl)-acetamidine (I). Similarly, di-(*p*-cyanophenyl)-acetamidine (II) has been obtained by condensing *p*-cyanoacetanilide with *p*-cyano-aniline. These compounds (I and II) are being converted into diamidine and triamidine derivatives respectively, *via* their corresponding imino ether hydrochlorides.

83. Synthesis of 3-Methyl-4″-Methyoxy-7′:8′-Furoflavone, by the Kostanecki and Feuerstein reaction, from 3-Methyl-4-Hydroxy-5-Acetyl-Coumarone.

S. D. Limaye *and* G. V. Bhide, Poona.

3-Methyl-4-hydroxy-5-acetyl-coumarone, m.p. 70°, (Limaye and Nagarkar, *Rasayanam*, 1943, *1* 256), (I), gave on condensation with anisaldehyde a compound, m.p. 152°, $C_{19}H_{16}O_4$, giving colouration with ferric chloride and regenerating on hydrolysis the original ketone and aldehyde, and hence represented as (3′-methyl-4′-hydroxy-coumarone -5′) (4-methoxy-styryl) ketone (II). The acetate of (II), $C_{21}H_{18}O_5$, m.p. 108-109°, (III) gave by the action of bromine (one mol.) in acetic acid a monobromide, m.p. 170°, $C_{19}H_{15}O_4Br$, (IV), giving colouration with ferric chloride and forming an acetate, m.p. 135°, $C_{21}H_{17}O_5Br$. Since (IV) was also obtained from 2-bromo-3-methyl-4-hydroxy-5 acetyl-coumarone, m.p. 123°, $C_{11}H_9O_3$ Br, prepared from (I), by condensation with anisaldehyde, it could be represented as the 2′-bromo-derivative of (II). With two mols. of bromine (III) gave a compound, m.p. 152°, $C_{21}H_{17}O_5Br_3$, (V), which on treatment with hot alcoholic NaOH gave a compound, m.p. 240°, $C_{19}H_{13}O_4Br$, (VI), suffering on hydrolysis acid and ketone splitting yielding 2-bromo-homokaranjic acid, m.p. 226° (decomp) and (I). Hence (VI) could be represented as 2-bromo-3-methyl-4″-methoxy-7 :8′-furoflavone, and (V) as (2′-bromo-3′ methyl -4′-acetoxy -coumarone-5′) (4-methoxy--styryl) ketone dibromide. However, when (III) was brominated in ether (3′-methyl-4′-acetoxy-coumarone-5′) (4-methoxystyryl) ketone dibromide, m.p. 145-46° (decomp.), $C_{21}H_{18}O_5Br_2$, was obtained, which on alkali treatment gave the bromine free 3-methyl-4″-methoxy-7′:8′-furoflavone, m.p. 223°, $C_{19}H_{14}O_4$, yielding on hydrolysis homokaranjic acid (Limaye and Limaye, *Rasayanam*, 1939, *1* 161). This procedure is utilised in similar syntheses which will be reported in due course.

84. Synthesis of (3-Methyl-6-Hydroxy-Coumarone-7)-Styryl Ketone and 3-Methyl-5′:6′-furo-Flavanone.

S. D. Limaye *and* K. G. Marathe, Poona.

By the condensation of 3-methyl-6-hydroxy 7-acetyl-coumarone (Limaye and Sathe, *Rasayanam*, 1936, *1*, 48), with benzaldehyde in the presence of sodium hydroxide, two isomeric compounds have been obtained viz., (3-methyl-6-hydroxy-coumarone-7)

-styryl ketone, (I) m.p. 140°, $C_{18}H_{14}O_3$, giving colouration with ferric chloride, and 3-methyl-5′:6′-furo-flavanone, (II), m.p. 184°, giving no colouration with $FeCl_3$. (I) regenerates on hydrolysis the original ketone and aldehyde. Condensation products with other aldehydes are also in hand and will be reported separately.

85. Condensation of 2:4-Diacetyl-Phenol with Benzaldehyde.

S. D. Limaye *and* H. K. Pendse, Poona.

In all, four products have been isolated in the condensation of 2:4-diacetyl phenol and benzaldehyde viz. :—2-Hydroxy -5-acetyl- phenyl styryl ketone, m.p. 89°, $C_{17}H_{14}O_3$, giving colouration with ferric chloride (I); 6-acetyl-flavanone, m.p. 152°, $C_{17}H_{14}O_3$, (II); (2-hydroxy-phenylene-1:5)-bis-(styryl ketone) m.p. 155, $C_{24}H_{18}O_3$, giving colouration with ferric chloride, (III); and 6-cinnamoyl- flavanone, m.p. 170°, $C_{24}H_{18}O_3$, (IV). By the action of alcoholic hydrochloric acid (I) is converted into (II); and (III) into (IV). Caustic alkali converts (II) and (IV) into (I) and (III) respectively. Further, (II) gives under the action of sodium hydroxide (III) indicating the splitting off of benzaldehyde and its recondensation with the other acetyl group from (I) formed in the reaction.

The condensation products have been used for further syntheses which will be reported separately.

86. Thermal Rearrangement of the Para-Allyl Ether of Methyl β-Resorcylate.

S. D. Limaye *and* C. V. Kunte, Poona.

In contrast to the observation of Baker and Lothian (J.C.S., 1936, 274) in the case of the para allyal ether of ethyl β-resorcylate, the para allyl ether of methyl β-resorcylate has yielded a Claisen transformation product, which on hydrolysis gives an acid, m.p. 140°, $C_{10}H_{18}O_4$, which may be represented as 3-allyl- β-resorcylic acid by analogy.

87. Action of Sodium Carbonate Solution on Coumarilic Acids.

S. D. Limaye *and* C. G. Joshi, Poona.

The following coumarilic acids suffer decarboxylation under the action of boiling sodium carbonate solution yielding the corresponding coumarones, which is in contrast to Pechmann and Hanke's observation in the case of 6-hydroxy-3-methyl-coumarilic acid (*Ber.*, 1901, *34* 354):—(i) 6-hydroxy-5-ethyl-3-methyl-coumarilic acid m.p. 222°, (Thakar, M.Sc. Thesis, Bom. Uni., 1946); (ii) 6-hydroxy--7acetyl-3-methyl-coumarilic acid, (Limaye and Sathe, *Rasayanam*, 1936, *1* 48); (iii) 6-hydroxy-7-benzoyl-3-methyl-coumarlic acid m.p. 239°, (Patwardhan, M.Sc. Thesis, Bom. Univ. 1938); (iv) 6-hydroxy-7-benzoyl-5- ethyl-3-methyl-coumarilic acid, m'p' 260°; (v) 6-hydroxy-7-p-toluoyl-3-methyl-coumarilic acid, m.p. 265°; (vi) 6-hydroxy-7-p,-toluoyl-5-ethyl-3-methyl-coumarilic acid, m.p. 260°.

The effect is more pronounced in the case of coumarilic acids having simultaneously an ethyl and an aroyl group in their 5th and 7th position respectively.

88. Synthesis of 4-Methyl-6-Ethyl-2′-(4″-Methoxy-Phenyl)-Coumarin-7:8-γ-Pyrone and 4-Methyl-7′-Ethyl-2′-Anisylidene-4′:5′-α-Pyrono-Coumaranone.

S. D. Limaye *and* M. G. Marathey.

4-Methyl -6-ethyl-7-hydroxy-8-acetyl-coumarin (Limaye and Limaye, *Rasayanam*, 1941, *1*, 201) gave on condensation with anisaldehyde (NaOH), 4-methyl-6-ethyl-7--hydroxy-coumarine-8- (p-methoxy-styryl)-ketone, m.p. 185°, $C_{22}H_{20}O_5$, (I): acetate, m.p.155°, $C_{24}H_{22}O_6$, (II); benzoate, m.p.165°, $C_{29}H_{24}O_6$; methyl ether, m.p. 128°, $C_{23}H_{22}O_5$. (I) and (II) gave their dibromo derivatives m.p. 158°, $C_{22}H_{20}O_5Br_2$, (II) and m.p. 170°, $C_{24}H_{22}O_6Br_2$, (IV) respectively, both of which furnished on treatment with cold sodium hydroxide solution a compound m.p. 290°, $C_{22}H_{18}O_5$, represented as a flavone since it splits off p-methoxy acetophenone on hydrolysis with caustic alkali. On boiling (IV) with ethyl alcohol the β-ethoxy-derivative m.p. 168°, $C_{26}H_{27}O_7Br$, was obtained which on treatment with sodium hydroxide solution yielded a compound m.p.

297°, isomeric with (V) but unaffected by boiling caustic alkali under identical conditions and hence could be represented as the corresponding anisylidene-coumaranone.

89. Effect of Propylation on the Course of Hydrolysis of 7-Hydroxy-8-Acetyl-4-Methyl-Coumarin.

S. D. LIMAYE *and* K. R. CHANDORKAR, Poona.

In keeping with the observations of Limaye and Sathe (*Rasayanam*, 1936, *1* 36), on the effect of methylation on the hydrolysis of 7-hydroxy-8-acetyl-4-methyl-coumarin (I) (Limaye, *Ber*, 1932, *65*, 375) the propyl ether of (I) $C_{15}H_{16}O_4$, m.p. 102° (II) gives on hydrolysis with sodium hydroxide under different conditions two isomeric 2-hydroxy--3-acetyl-4-propyloxy-β-methyl-cinnamic acids, $C_{15}H_{18}O_5$, One of them m.p. 140° (decomp.) (III) yields on heating above its m.p. (II), with the loss of a molecule of water, while the other isomer m.p. 168° (decomp) (IV) suffers decarboxylation on similar treatment yielding 2-hydroxy-3-acetyl-4-propyloxy-isopropylene-benzene, m.p. 46°, $C_{14}H_{18}O_3$. Hence (III) and (IV) have been represented as the cis and trans stereoisomers. Methyl ether of (III) $C_{16}H_{20}O_5$, melts at 90° while that of (IV), at122°. In view of the limited number of stable coumarinic acids the isolation of (III) is significant.

90. Synthesis of 4-quinazolols.

A. B. SEN *and* M. P. UPADHYAYA

Two new 4-quinazolones, 2--methyl-3α- naphthyl-(m.p.152°C) and 2-methyl-3n-butyl (b.p.250°C at 8 mm.), have been synthesised by the action of N-acetyl anthranilic acid, primary amine and phosphorus trichloride. From these the following seven 4-quinazolols were obtained by treatment with different alkyl or aryl magnesium halides followed by decomposition with dilute sulphuric acid.

-4-quinazolols.			Yield %	M.P. °C	Nitrogen Found	Nitrogen Actual	M.P. of acetyl derivative °C
1.	2-methyl-3αnaphthyl	4-propyl-	70.5	190	8.3	8.48	145
2.	” ”	4-phenyl-	80.3	210	7.8	7.69	145
3.	” ”	4n-butyl-	87.2	162	8.0	8.14	95
4.	” ”	4-*p*-tolyl-	66.1	172	7.19	7.4	150
5.	2-methyl-3n-butyl	4-phenyl-	85.0	165	9.4	9.52	105
6.	” ”	4-propyl-	86.7	170	10.6	10.7	—
7.	” ”	4-*p*--tolyl-	47.0	162	8.98	9.09	165

91. The action on Bacillus Coli of some mercurated phenyl ureas

KHIRODE PATNAIK *and* S. S. GUHA SIRCAR.

The object of the present investigation is to explore the antiseptic activity of a group of phynyl ureas, phenyl thioureas and their mercurated derivatives. The methods described in the literature for their prepration were compared by trials and those most suitable were employed, The mercuration was carried out in the cold by the usual methods and the 'gold-crucible' method was employed for the estimation of mercury. The Rideal-Walker 'serial dilution' method was used for comparing the activities of the products, a 24 hours' culture of B. Coli communis being used as the test organism. The following substituted ureas and thio ureas were studied.

Ph, o-, m-, & p- tolyl; o-, m-, & p-chlorophenyl; o-, m-, and p-nitro-phenyl; a-& b-naphthyl; o-, m-, & p-carboxyphenyl.

92. The action on Bacillus Coli of some mercurated Phenyl Ureas.

KHIRODE PATNAIK *and* S. S. GUHA SIRCAR.

13 derivatives of phenyl urea have been mercurated with mercuric acetate and the bacteriostatic action on Bacillus Coli of both the phenylureas and of their mercurated

products have been studied. In every case there is a large increase of activity on introducing the metal. The first group prevented the growth of the organism in dilutions varying from 1: 200 to 1: 700 whereas the second group did the same at dilutions varying from 1 in 19,000 to 1 in 160,000. The corresponding phenylthioureas had activities of similar order to the phenylthioureas. The mercurated compounds, however, being either too sparingly soluble, or decomposing on keeping or on warming with water, could not be investigated biologically.

93. Chemistry of β-Aryl Glutaconic Acids.

H. S. Agaskar *and* G. R. Gogte, Bombay.

The work of acylation of β aryl glutaconic anhydrides (Gogte : Proc. Ind. Acad. Sci. Vol. VII No.3, March 1938, p.221) has been extended to β. 1. methyoxy naphthyl.4 glutaconic anhydride (Gogte: Proc. Ind. Acad Sci Vol. I No. 1, July 1934, p.56) and the compound, c acetyl anhydride m.p. 182°was obtained.

The acylation reaction is further extended to anils obtained from different glutaconic acids, the acetylation being carried out by acetic anhydride and sodium acetate fused as well as by acetyl chloride and pyridine. In all the cases c-acetyl anils are formed. They give violet colouration with ferric chloride, titrate as monobasic acids, and are converted into original anils by hydrolysis with hydrochloric acid.

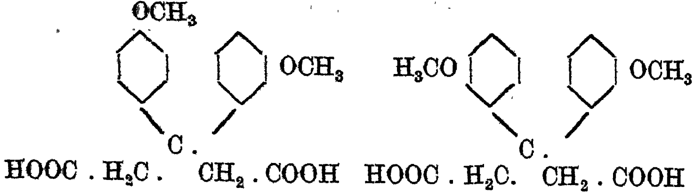
On the other hand when these anils are subjected to benzoylation, they are found to give neutral benzoyl derivatives, which also give back the original anils on hydrolysis with alkalies.

Thus anils can have both, neutral and hydroxy, structures.

94. ββ-Di-Aryl-Glutaric Acids.

G. R. Gogte *and* V. K. Atre, Bombay.

The constitutions of the ββ-di-(-4-hydroxy-phenyl-)-glutaric acid m.p. 234°dec, and of the ββ-di-(-4-methoxy-phenyl-glutaric acid m.p. 156° dec., have been conclusively proved by Gogte (Proc. Ind. Acad. Sci., 1935, 2*A* 185). Dixit and Padukone (Proc. Ind. Sci. Cong., 1948 p-30) however assigns the structure β-(-4-hydroxy-phenyl-)-β'-(-2-hydroxy-phenyl-)-glutaric acid to the first compound, which is quite untenable in view of the fact that the decarboxylation product of the ββ-di-(4-methoxy-phenyl-)-glutaric acid was found to be identical with the known αα'-di-(-4 methoxy-phenyl-)-ethylene (Gattermann, *Ber*, *22*, 1132.) To prove the point beyond doubt, we have actually synthesised the β-(-4-merhoxy-phenyl-) β'-(-methoxy-phenyl-)-glutaric acid m.p. 88° dec. (I)



and the ββdi-(-2-methxy-phenyl-)-glutaric acid m.p. 164-5° dec. (II). The structures of these compounds have been established by synthetical and analytical methods,

95. Pyronine dyes from Muconic acid.

Ram Das Tiwari, Allahabad.

The effect of the unsaturated chromophores on the pyronine dyes has been studied before by comparing the dyes derived from succinic acid and maleic acid (Tharamdas and Tewari : Proc. Ind. Acad. Sci. 1941, *13*, 68.). In the present communication the dyes derived from adipic acid have been compared with those from muconic acid. Muconic acid was prepared from adipic acid through αα' dribromo-diethyl adipate. The acid was then condensed with various aromatic hydroxy compounds. The propoerties of the dyes were studied and their absorption maxima were determined.

96. Studies of the Dyes obtained from Acetone Dicarboxylic Acid

S. S. Baijal *and* J. D. Tewari

Acetone dicarboxylic acid has been condensed with phenols, phenolic ethers, and resorcinol by Dixit, Lemaye, Pechman, and Mulay. They obtained nearly colourless compounds and they have shown that in all cases the condensation takes place in β-carbon atom. In our studies the acid is condensed with various aromatic hydroxy compounds at 180°-200°C with a few drops of concentrated Sulphuric acid as condensing agent, when bright coloured products have been obtained. The compound wth resorcinol gave deep red colour with blue fluorscence.

97. Studies on the Chromatographic method of Separation of Individual sterols from a Phytosterol Mixture from the Oil of Jute seed-Corchorus Capsularis.

N. K. Sen *and* P. R. Dasgupta, Calcutta.

The unsaponifiable matter is separated by the method of Jameison. After evaporating off the ether the phytosterol mixture is preciptiated from methyl alcohol. Four different fractions of which three are sterols and the other is a hydrocarbon, have been separated. The white voluminous flocculent precipitate of phytosterol having its melting point at 122-125 degrees centigrade, is dissolved in ether and the solution is next chromatoghraphed through a column of Brockmann alumina (10cms × 1.5 cms). Under ordinary light the column is like,--

Top 0.5 cm. approx.	Sand colour gradually thinning into white
Middle	Three or four narrow bands of faint greenish yellow colour separated from each other by 0.5 cm.

Under ultra-violet rays the column is like,—

Top 0.5 cm.	Sand coloured fluorescence
Middle	Three or four narrow greenish yellow fluorescent bands separated from each other by 0.5 cm.
Other zone	Blue fluorescence.

Top layer of the chromatogram is removed and the rest is then eluted with ether and from the elute a fraction (A) is obtained and purified by repeated chromatography. Following are the characteristics of this fraction.

Liebermann reaction—positive; Libermann-Buchard reaction—positive; Crystalline shape-Clusters of needles when precipitated from ether; m.p.—128 degrees centigrade; m.p. of the acetate-123 degrees centigrade; forms digitonide subliming at 222-225°C

A second fraction (B) is obtained from the filtrate of chromatographic operation with the following characteristics; Libermann reaction-positive; Liebermann-Buchard reaction-positive m.p.116°C.

The coloured top layer yielded still another fraction (C) on elution with ether in very minute quantity and responding to colour reactions.

A fourth fraction (D) of semi-solid consistency metling ot 100°C and of colour light greenish yellow is obtained also from the filtrate. This is found to be a hydrocarbon after preliminary tests.

98. A bromo analogue of Paludrine.

H. L. Bami, Delhi.

Biguanide as a basic chemical structure for the synthesis of new potential antimalarials has received considerable attention since the discovery of Paludrine. Bami *et al.* synthesised a number of substituted biguanide derivatives (*J.Indian Inst.Sci.*, 1947 *29A*. 15; 1948, *30A* 1,9; 1949 *31A*, 9) some of which when tested against experimental malarias, showed moderate antimalarial activity (Bami *et al. Current science*, 1949, *18*, 50). Various simpler analogues and isomers of paludrine were also synthesised (Bami and Guha, *Current Science*, 1948, *17*, 272) and their antimalarial screening tests revealed the exceptional potency of p-bromo-analogue of paludrine (N'-p-bromophenyl-N5–isopropyl- biguanide) (Bami *et al.*, *ibid*, 1949, *18*, 50). This potency compared favourably with that of paludrine. Improved methods for the preparation of this drug (Bromoguanide) have been investigated in order to prepare it in quantities sufficient for detailed pharmacological studies. A soluble lactate salt of Bromoguanide has also been prepared for injections. Further researches in the field of bromo-substituted biguanide derivatives are in progress.

99. Chlorination of Cholesterol by means of Thionyl Chloride.

(Mrs.) P. A. RAO *and* AZIZUR-RAHMAN, Aligarh.

The present authors have carried out the chlorination of cholesterol by means of thionyl chloride by Diel's and Blumeberg's methods with a view to obtain the epi form of Chloesteryl chloride, the isolation of which would help in tracing the exact step at which the Walden Inversion occurs in the synthesis of Androsterone from chlesterol.

The authors have surprisingly noted that their observations do not tally with those mentioned by the previous workers. They have invariably observed the formation of a sticky mass in the reaction mixture which is not easily manageable for crystallization. Ethyl acetate has been found to dissolve the stickly mass completely. Seeding and cooling the substance in the refrigerator yields the required crystals.

Some deviation from the previous procedure of isolation of the chloride has also been successfully attempted.

Modifications in the suitable solvent for crystallization have also been done. Crystals are obtained in two crops by acetone-alcohol mixture and ethyl acetate-alcohol mixture from the solid and sticky mass respectively, which are seperated in the reaction mixture twenty hours after chlorination.

100. On the Bromination of Cresol

N. ROY, Calcutta.

The ortho and para isomers of Cresol in a dilute solution are apt to be over brominated. A process of inhibiting this over bromination of the Cresols has been worked out, which is found to be independent of temperature as well as the concentration of bromine or acid added. A mechanism of the overbromination of Cresol and its inhibition has also been explained. This process leads to establishing an easy and accurate method of estimating cresol by bromination, the bromine equivalent of Cresol being the calculated 4.8 moles of bromine according to the theory of substitution.

101. Studies on the Component fatty acids of the Fatty Oil from the seeds of Ipomea Muricata.

ANAND LAL MISRA *and* JAMUNA DUTT TEWARI, Allahabad.

While extracting the seeds of Ipomea Muricata in connection with the studies on the glucoside from the seeds, a fatty oil in 8.4% yield was obtained. This oil had been previously examined by Kelkar, Phalnikar and Bhide (J.I.C.S., 1947, 87), but on comparison of the important constants a vast divergence was noticed. The oil was therefore carefully examined.

The mixed fatty acids were found to have palmitic (7.77%), stearic (11.43%), dihydroxy-stearic acid and another acid of m.p. 108-109°C (1%), linolenic acid (1.125%), linolic (18.54%), Oleic (58.6%), among the solid acids, the first two fractions yielded Palmitic and stearic acids but no behenic acid (m.p. 80-81°C) was obtained, as reported by previous worker. From the last fraction we have isolated an acid in small yields of molecular. wt. 310 (Silver salt method) of m.p.135-140°C. It was subsequently identified to be dihydroxysteraric acid. The other acid got had a m.p. 108-109°C which has also been obtained by the oxidaon of glucosidic resin contained in the seeds by Singh and Tewari (Proc. Ind. science Congress 1949, 186).

The finely powdered seeds were extracted with Petroleum ether. The oil had a sap. value of 192.3 and an iodine value of 83.26. The mixed fatty acids (N.V.198.) of semi-solid consistency were separated into saturated and unsaturated acids by Pb-salt alcohol process. The percentage of solid acids (Bertram's Oxidation method) was 19.66%.

A qualitative determination of unsaturated liquid acids (N.V. 189.2 ; I.V. 130.23) was effected by $KMnO_4$ oxidation method of Hazura. By Jamieson's bromination the percentage of liq. acids comes out to be oleic 73.26% ; linolic 23.17% ; linolenic 1.406%.

The solid saturated acids (N.V. 201.7 ; I.V. 0.82) were converted into methyl esters and fractionally distilled at 32 mm. pressure and the different fractions got were hydrolysed. The component acids were palmitic, stearic and a little amount of dihydroxy stearic acid and an acid m.p. 108-109°C identical with that got by oxidation of glucosidic resin contaned in the seeds.

The unsaponifiable matter (1.09%) (m.p.-129-130°C) gave the colour reactions of a phytosterol. Its acetyl derivative has a m.p. 121-122°C.

102. Cashew Nutshell Liquid : Preliminary Investigation of the Double Bond character of the Monophenol from Commercial Raw Cashew Nutshell Liquid

V. J. Paul, N. T. Mathew, G. Ram Mohan *and* Lourdu M. Yeddanapalli, Madras.

The recent investigation of Wasserman and Dawson (Ind. Eng. Che., *37*, 396, 1945) and of Sletzinger and Dawson (J. Am. Chem. Soc. *68*, 345, 1946) indentified the monophenol from commercial raw cashew nutshell liquid by vacuum distillation as 3-pentadecadienyl phenol with two double bonds in the side chain, of which one was assigned the 8-9 position from the nucleus.

Our investigation is concerned with the nature of the double bonds in the side chain of the monophenol obtained from the same commercial liquid distilled at various pressures from 2 to 760 mm. Hg. The number of double bonds in the samples distilled at different pressures was evaluated by their iodine values found with the help of Woburn type of iodine-bromine solution (J. D. von Mickusch and Charles Frazier, Ind. Eng. Chem. Anal. Ed. 13, 782, 1941). The 2 mm pressure distilled phenol contains 1.95 double bonds per molecule, but this number decreases with increase in the pressure of distillation, the value for the atmosheric sample is only 0.71. From these results and from oxidation products of the phenol, evidence is presented for the heterogeneity of double bonds both as to number and their relative position in the side chin. Further investigation is in progess.

103. Estimation of Cresol

N. Ray, Calcutta.

Cresol is a mixture of its three isomers being present in the proportion of o : m : p = 35 : 40 : 25. The simple theory of ortho-meta para substitution requires 4.8 moles of bromine per mole of the cresol. But owing to overbromination of some of the isomers of the cresol it has been found that 6.79 moles of bromine are actually required for one mole of Cresol. This more or less arbitarry bromine equivalent found out by the present method laid down in this paper, is based on the value of cresol estimated colorimetrically with phenol reagent as enunciated by Chapin. The colorimetric estimation of B.P. Cresols would also show that they contain only 83-87% Cresol, the rest being the moisture and other nonphenolic bodies— a fact which has been corroborated by the present method of estimation of Cresol also.

104. Thermal decomposition of Metal Alkyls: Tin and Silicon Tetramethyls.

T. V. Sathyamurty, S. Swaminathan *and* Lourdu M. Yeddanapalli, Madras.

A fairly thorough investigation of the vapour-phase thermal decomposition of aluminium trimethyl by one of us (Lourdu M. Yeddnapalli and Clarence C. Schubert, J. Chem. Phys. 13, 1, 1946) assigned a three-halves kinetic order to the process in terms of a free-radical mechanism and suggested the possibility of a similar kinetic behaviour for other metal methyl alkyl decompositions. Attempt has therefore been made to re-examine the results of the thermal decomposition of tin tetramethyl reported by Waring and Horton (J. Am. Chem. Soc. 67, 540, 1945) and to show that the results fit in better with a three—halves order rate expression and a free radical mechanism, rather than with a unimolecular rate, and a molecular rearrangement process put forward by Waring and Horton to account for the observed reaction products.

Further the experimental results reported earlier on silicon tetramethyl thermal decomposition by Helm and Mack (J. Am. Chem. Soc. 59, 60, 1937) in the low pressure region not amenable to first or second order rate expressions, have successfully been interpreted in terms of three order and a radical mechanism. The study of the kinetics of mercury dimethyl and zinc dimethyl is in progress in our laboratory.

105. Hydrolysis of Sulphonamides by Sulphuric Acid

D. D. KARVE, K. K. DOLE *and* R. D. SONATAKKE,
Poona.

Hydrolysis of the aromatic sulphonamides has been carried out at different temperatures with different concentrations of the catalysing acid. The sulphonamides investigated include,

(1) Benzene Sulphonamide
(2) p-Acetylamino benzene Sulphonamide
(3) p-Toluene Sulphonethylamide.

Their study showed that at moderately high temperature (120° to 150°C) the hydrolysis proceeded at a measurable rate and followed the unimolecular law fairly accurately. The increase in the concentration of the catalyser acid (20N to 30N), and the increase in the temperature of the reactions (120° to 150°C) favours the reaction with a temperature co-efficient of about 2.5

The hydrolysis of p-Acetylamino benzene-Sulphonamide proceeded at a rate faster than that for p-Toluene Sulphon-ethylamide. Benzene Sulphonamide hydrolysed still faster. Thus the order of decreasing reactivity was found to be (1) Benzene Sulphonamide (2) p-Acetylamino-benzene Sulphonamide (3) p-Toluene Sulphon-ethylamide.

Biochemistry

106 On the Mechanism of the Action of Sanguinarine.

S. N. SARKAR, Calcutta.

The isolation of sanguinarine from argemone oil and its toxic effect on various enzyme systems and on albino rats were reported in an earlier communication (Nature, 162, 265, 1948). The mechanism by which sanguinarine inactivates the pyruvate oxidiase system (which is very sensitive to -SH inhibitors) resulting in the accumulation of pyruvate in the blood of the poisoned rats has now been clearly elucidated. Sanguinarine chloride has been found to combine with one molecule of a monothiol with elimination of HCl. In the case of a dithiol (B.A.L.), a similar reaction takes place with each—SH group. This phenomenon can be readily explained by the extension of an observation made by Hope and Robinson (J., 2114, 1911) in connection with their work on cotarnine. They suggested that in a structure of type (a) R. CH:N(OH)R′R″, the positive ion can combine with the negative residue of a substance H.X to form a complex of type (b) R.CH:N(X)R′R″ and this being unstable passes into type (c) R.CH(X).NR′R″. In the case of combination with —SH groups, X may be represented by SR.

Now taking into consideration the toxic effects of sanguinarine observed by the author along with the results of argemone oil feeding to human volunteers by Chopra *et. al.*, Pasricha *et al.*, and Lal *et al.*, it may be said that argemone oil may produce epidemic dropsy.

107. Comparison of Adsorptive Properties of Yeast Invertase on Suitable Adsorbents.

M. M. BISWAS, Calcutta.

Comparative studies have been made of the adsorptive properties of Yeast invertase on adsorbents like activated alumina gel, bentonite, colloidal Kaolin and activated charcoal. The adsorbents were prepared and purified in the laboratory with special care. Yeast invertase has been found to be most efficiently adsorbed on activated alumina gel and the enzyme extract after elution with a buffer mixture of pH 5.4 (0.3 N acetic acid and 0.3 N NaOH) has given the maximum invertase activity.

108. Studies on Fungal Protease. Part I.

B. M. Das *and* Sudhindra Nath Sen.

Studies with different fungal protease have been undertaken with the primary object of using these enzymes as bating agents for hides. Results so far obtained indicate that Aspergillus paraciticus produces stronger and stable protease than Aspergillus Oryzae. Cultures obtained from some of the isolated individual spores have yielded strains of A. paraciticus having protease activity much stronger than the mother strain. It is expected that this technique in combination with the method of electromagnetic irradiation used for increasing microbial enzymic activity would yield far stronger protease preparations.

109. Source of Nitrogen and Citric Acid Formation.

M. Damodaran *and* S. Dutta, Poona.

Although the production of citric acid by the fermentation of glucose and cane sugar by *Aspergillus niger* is in commercial use, it is well known that the fermentation is extremely sensitive to the raw material used as a source of sugar. As part of an investigation on the various factors in the culture medium which determine the course of the fermentation the influence of various organic sources of nitrogen especially amino-acids has been studied. The following substances were used: asparagine, aspartic acid, glutamic acid, glycine, leucine, lysine monohydrochloride, casein and egg albumin hydrolysates and urea. It was found that the nature of the nitrogen source profoundly influenced not only the growth of the fungus mat but also the amount and nature of the acid formed. With asparagine, urea and glutamic acid citric acid formation was not much lower than with ammonium nitrate (between 50 to 60%). In the case of the protein hydrolysates and aspartic acid the amount of acid formed was appreciably lowered (between 30 to 40%) and with lysine monohydrochloride it was very much lower (about 15%). With leucine acid formation was largely suppressed. Glycine was found not only to suppress acid production but also to alter the nature of the acid formed, oxalic acid being the main product of the fermentation.

110. Effect of Inhibitors of Glycolysis in Citric Acid Fermentation.

M. Damodaran *and* P. N. Rangachari, Poona.

For the elucidation of the intermediary metabolism of *Aspergillus niger* in the citric fermentation one of the crucial questions to be answered is as to the existence of glycolytic reactions. Previous investigations on this question by the use of inhibitors of glycolysis, iodoacetate and fluoride have not yielded conclusive results. The effect of iodoacetate, fluoride and phloridzin have been investigated in detail regarding their influence on the growth and metabolism of *Aspergillus niger*.

Iodoacetate added in concentrations ranging from M/400 to M/1000 to preformed mycelium of *Aspergillus niger* on a glucose medium completely inhibited both utilization of sugar by the fungus and acid formation. Fluoride at a concentration of M/150 resembled iodoacetate in suppressing both acid formation and sugar utilization but at lower concentrations, M/200, M/250 and M/300, acid formation alone was suppressed; sugar was still utilized but only at about half the rate of normal controls. Phloridzin in concentrations of M/50 and M/100 completely inhibited acid formation but did not prevent sugar utilization. At a concentration of M/150 the acid formation was reduced to 50% but sugar utilization was normal. Phloridzin in concentrations of M/10 to M/150 when used along with Currie's medium and inoculated with the fungus spore did not prevent sugar utilization but inhibited acid formation to about 30 to 50%. The uptake of inorganic phosphate from the culture medium was the same as that in the control.

111. Study on the Starches of Cereals and Pulses of Gujarat.—Part I—Physical and Chemical Properties.

C. C. Shah *and* R. D. Patel, Anand.

A systematic study of the starches from the cereals and puleses has been undertaken. In this part, the method of extraction and the physical and chemical properties have been dealt with. The food grains selected for the study are:—

Pisum sativum, Phaseolus Mungo, Vigna Catjung, Cajnus Cajan, Cicer Arietinum, Dolichos Lablab, Phaseolus aconitifolius, Lens esculanta, Phaseolus rabiatus, Pisum sativum var arvense, Hordeum vulgare, Triticum aestivum, Paspalum Serobiculatum, Zea Mays, Andropogon sirghum, Pennisetum glaucum, Eleusine Coracana, Oryza sativa, Setaria italica, and the properties investigated are alkali-labile value, copper number, viscosity, Nitrogen content, Phosphorus, moisture, ash and structure (Microphotographs).

112. Mode of Action of Antioxidant in Vitaminised Oil.

U. P. Basu *and* Sukhamoy Bhattacharya.

Vitamin A is an unsaturated body and is susceptible to oxidation. Highly oxidised vitamin A has no biological activity and as such if the inherent cause and mode of oxidation be known, it would be much easier to control the deterioration of vitamin A in any vitaminised oil preparation. The autoxidation of fat is now believed to be due to the formation of a free radical by detachment of an alpha methylenic hydrogen ion (*cf.* Farmer, *Trans. Farad. Soc.*, 1946, *42*, 228). If the vitamin molecule behaves in such a way, then nature of diluent would play a secondary part and the hydroxy phenolic antioxidant by preventing the formation of hydro-peroxide would protect the vitamin from deterioration. Under such circumstances and according to the observations of Calkins (*J. Amer. Chem. Soc.*, 1947, *69*, 384) an acid inhibitor by donating proton would further help in regenerating the hydroxy antioxidant that is being bound up by the unsaturated complex of the vitamin molecule, and thereby help in preventing the formation of peroxide by the unsaturated complex.

Experimental observations are being recorded to justify the mode of action of the antioxidant in retarding the onset of oxidation in Vitamin A.

113. Nutritive value of Some Local Food Stuffs.

M. N. Rudra, Darbhanga.

The protein contents and vitamin C contents of some local foodstuffs have been investigated and found to be higher in the case of some articles than the values reported from other areas.

114. Methionine Estimation in Foodstuffs.

M. N. Rudra *and* L. M. Choudhary, Darbhanga.

Csonka and Denton's method of estimating methionine colorimetrically has been modified and improved. The modified method gives trouble-free manipulations and excellent results. Estimated by this method khesari dal, rice and mung dal have been found to contain 0.06, 0.21 and 0.28 percent of methionine respectively. We think this extremely low methionine content of khesari is one of the etiological factors in lathyrism.

115. Studies on Experimental Diabetes.—Part I—Effect of Aceto-acetate on the Glucose Tolerance and Glycogen Storage in Rabbits and the Comparative Effects of Insulin and Amellin on such Animals.

M. C. Nath *and* C. H. Chakrabarti, Nagpur.

1. Continuous injection of sodium acetoacetate with increased doses beginning from 50 mg/kg body weight, causes progressive hyperglycemia in rabbits after an initial hypoglycemic stage.

2. Glucose tolerance of these animals is reduced considerably after 30 days of injection. The glucose tolerance curves taken after 30, 50, 70, 90, 110, 130, days showed progressive development of diabetic tolerance.

3. Glycogen contents of liver and muscle get gradually depleted, the percentage depletion after 130 days of injection being 64.9 and 73.4 respectively.

4. One of the treated animals excretes glucose in urine after 175 days of injection. The percentage of glucose in urine of 24 hours sample is 0.8.

5. Amellin, when injected in the daily dose of 10 mg/kg. to the hyperglycemic animals for 40 days is found to reduce the blood sugar to 105 (normal value) from 171 mg per 100 c.c. blood, whereas insulin reduces the blood sugar of the treated animals to 182 from 186 mg per 100 c.c. Insulin is found to relieve hyperglycemia initially. After 20 days the animals behaved as insulin refractory cases. Increase in dose would lead to death of the animals.

6. Glucose tolerance of the animals treated with sodium acetoacetate becomes absolutely normal after amellin administration for 40 days, whereas the glucose tolerance of the similarly treated is different.

116. Indian Tea—Its Mineral and Other Contents.

S. K. CHATTERJEE *and* H. D. GANGULI, Calcutta.

Tea is used a common beverage all over the world, its stimulating effect is said to be due to the presence of caffeine (2%—3.5%) in it.

Tea is the dried leaves and buds of different species of Thea (genus Camellia). The greater portion of the tea is supplied from India, Ceylon, China and Java. The varities of the tea depend upon the age of the leaves at the time of picking them and upon the different methods of preparation. The quality of the tea is judged by expert tea tasters by tasting the infusions prepared from the tea leaves. But as adulterations are quite common it is necessary that we should depend upon some chemical tests for detection of the purity of the stuff. In the food adulteration Act there are three main datas, which one has to fall back upon. They are (1) the percentage of ash (4%—8%) (2) the proportion of this ash which is soluble in boiling distilled water (not less than 40%) and (3) the amount of soluble matter extracted from the leaf by boiling water (not less than 30%). It is interesting to note that neither caffeine nor tannin, the important constituents of tea plant, have been included in it.

Another important feature is the presence of manganese in the fragements of tea and in a fairly high proportion than any other plant products.

The common adulterants of tea leaves may be of mineral type, organic type, colouring matter or of astringent type. A skilful hand can mix any of these adulterants to a sample of tea without being detected under the food adulteration Act. The microscopic examination may be suspicious but the analytical figures will fall within the range of limits of those of the Act.

Under the circumstances it becomes necessary that the caffeine and the manganese contents of the leaves should also be determined to give a definite opinion as to its adulteration.

With this important aspect in view several samples of tea available in the Calcutta market have been analysed and the average caffeine and manganese contents there-of have been determined. It was also noted that the leaves possess a trace of Vitamin B but no Vitamin C in them. Green tea however contained 1 mg percent of Vit B_1 and a minute trace of Vit. C.

The results of analysis have been given in a tabular form with an account of the methods adopted in each case. The average value of the results in each case is given below.

Tea	Moisture	Ash	Manganese	Caffeine	Vitamin B_1	Vitamin C
Darjeeling	5.71	5.58	0.01779	4.142	Traces	Nil
Terai	5.43	5.71	0.01799	3.499	Traces	Nil
Dooars	5.02	5.38	0.011719	4.487	Traces	Nil
Sylhet	4.88	6.16	0.0562	3.366	Traces	Nil
Cachar	4.91	6.03	0.0540	3.197	Traces	Nil
Assam	4.96	6.36	0.1130	3.864	Traces	Nil
Green tea	6.50	7.01	0.0515	4.42	1 mg percen cent.	Minute traces.

117. Investigation on the use of Ice-containing Preservatives for the Preservation of Perishable Food-Stuff (fish).

A. N. BOSE *and* K. P. KOLAY, Calcutta.

Incorporation of sodium hypochlorite or sodium benzoate in ice, reduces the amount of ice needed to keep fish in fresh state during transport and storage, and increases the keeping quality of fish. While fish (Cyprinus Carpio) stored in ordinary ice will be inedible in 18 hours, it will remain practically fresh for 48 hours in the same amount of ice with 0.1% sodium hypochlorite or 0.8% of sodium benzoate. Highest concentration of preservative that can be incorporated in ice is limited by its penetration in the fish-tissue and by the alteration of flavour it causes. Maximum concentration of 0.1% of sodium hypochlorite or 0.8% of sodium benzoate can be used without affecting the taste of flavour. Sodium hypochlorite is better of the two preservatives as regards their action on mico-organism E. Coli.

Industrial Chemistry

118. Cellulose Ethers and Their Fractionation.

HITENDRA BHUSAN ROY, SADHAN BASU *and* SANTI R. PALIT.

It is difficult to fractionate cellulose ethers into a large number of fractions in order to get a complete view of the nature of molecular weight distribution curve, owing to the fact that lower cellulose ethers are highly soluble in water and the higher ones are soluble in almost all common organic solvents. It is known that cellulose dibenzyl ethers are soluble in a limited number of organic solvents and mixed solvents, and are completely insoluble in alcohols, higher hydrocarbons, ethers, etc. It is expected, therefore, that dibenzyl cellulose may be fractionated into a large number of fractions and an insight may be obtained into the nature of the distribution curve of the cellulose ether.

With a view to this, dibenzyl cellulose was prepared from Doria cotton of Bombay by the modified method reported in a separate abstract. One per cent solution of the ether in chloroform was fractionally precipitated with ethyl alcohol. When about 150 cc. of alcohol had been added per cc. of chloroform to the solution, rest of the ether was fractionated by precipitation with water. The result is given in the following table:

The figures in the last column give the values of intrinsic viscosity from which a differential and integral viscosity distribution curve can be easily constructed. It can be easily seen that the differential curve contains two humps, which is not unusual in such compounds. Since the Staudinger's constant for benzyl cellulose is not known, the calculation of molecular weight for various fractions was not possible. However, work on osmotic pressure measurements on these samples is in progress from which the D.P. will be evaluated and correlated with [η].

TABLE

25 cc. of 1.1% solution in chloroform of dibenzyl cellulose.

Fractions.	Amount of Precipitant.	gms. of Precipitate.	Intrinsic viscosity in chloroform.
I.	60 cc. EtOH	.1960	0.69
II.	+ 15 cc. ,,	.1848	0.40
III.	+ 20 cc. ,,	.1334	0.28
IV.	+ 25 cc. ,,	.0640	0.24
V.	+ 50 cc. ,,	0.500	0.17
VI. (concentrated to 5 cc).	+ 50 cc. ,,	.1000	0.14
VII. (concentrated to 2cc).	+ 75 cc. ,, and 5 cc. water	.1440	0.12
VIII.	+ 70 cc. water.	.1374	0.07
IX.	evaporated to dryness.	.0550	0.05

119. Modified Laboratory Method for the Preparation of Benzyl Cellulose from Cotton.

HITENDRA BHUSAN ROY *and* SADHAN BASU.

Doree's method of preparation of benzyl ether of cellulose gives a very poor yield of the dibenzyl ether when applied to the case of cotton cellulose. Consequently, the method was modified for the preparation of dibenzyl ether from Doria cotton of Bombay. The sodio-cellulose was prepared by treating the cotton with 20 to 30 per cent sodium hydroxide solution. The sodio-cellulose was then reacted with benzyl chloride under reflux. The process was repeated three times and finally the benzyl ether was washed, steam distilled and dried at 100° to 105°C. This method not only increases the yield from 5 to 55% but also cuts down the time of reaction by about 24 hours.

120. Hydrolysis of Starch.

M. Goswami *and* M. Bhowmik.

Great difficulties are to be overcome to carry out the simple reaction of adding one molecule of water to one molecule of cellulose or starch, on a plant scale in all existing processes of wet hydrolysis.

Following the new trend in the use of sulphur dioxide (as sulphurous acid) to convert starch into glucose as also in the use of hydrogen chloride gas in the dextrinisation of starch, we started our work on the saccharification of corn starch by investigating the effect of hydrogen chloride gas at various temperatures (D—100°C) and obtained a maximum conversion of 54% of reducing sugars (in terms of glucose). The use of additional catalysts like $CaCl_2$, $ZnCl_2$ etc. inhibits caramelisation of the product to a great extent. NO_2 and Cl_2 (0—80°C) give a maximum conversion of 30% of reducing sugars (in terms of glucose). The effect of inert gases like CO_2 together with hydrogen chloride gas on the rate of conversion was only appreciable at high temperature.

The exothermic reactions between hydrogen chloride gas and starch or cellulose has been very much facilitated by using organic solvents like carbon tetra-chloride benzene, chloroform and from a suspension of starch (20-30% moisture) in these solvents a maximum recovery of glucose of practically 100% has been obtained under normal conditions of temperature and pressure. Concentrated hydrochloric acid also gives similar results. The effect of temperature (50–70°C) on the rate of conversion is termendous in the latter case.

The remnant of acid may be removed by heating the suspension of product in high boiling liquid like decalin or by bringing the liquid product of acid conversion of dextrose polymer in contact with resinous reactions of formaldehyde and m-phenylene diamine or other amine of the general formula RNX or by distilling the product in vacuo and subsequent spray-drying.

121. Electro-Deposition of Manganese.

B. N. Ananthan *and* S. Husain, Hyderabad-Deccan.

A systematic study of the electro-deposition of manganese was undertaken. It was found that the addition of ammonium sulphate to manganese sulphate solutions facilitated the deposition of manganese. The brightness of the deposits obtained was enhanced by the addition of triammonium citrate to the manganese sulphate-ammonium sulphate baths, the deposits obtained being very thin. As against the sulphate baths, the citrate baths were free from slime, the addition of citrate preventing the anodic oxidation manganese ions. It was, however, found that the yield in the case of the citrate baths was very poor, which as the potential measurements indicated, was due to the cathodic potential becoming more negative.

122. Investigation of the Possibilities of the Manufacture of Calcium Carbide and Bleaching Powder from Hyderabad Lime Stone.

D. S. Datar *and* S. Husain Zaheer, Hyderabad-Deccan.

Though the raw materials used in the manufacture of Calcium Carbide occur in abundance, further enquiry has shown that they are not of the requisite quality. They contain magnesium oxide and silica in prohibitive quantities. It is estimated that more than 25% of power will be consumed due to interactions of these impurities and the product will be excessively impure. Lime stone available in the State contains 1-2% of magnesia and 10-30% of silica and is also not suitable for the bleaching powder manufacture. Experiments conducted for the mechanical separation of silica from lime stone taking recourse to the elutriation and size separation were of no avail. It is shown that the carbide or bleaching powder industry have no prospects in the Hyderabad State.

123. Cryoscopic Studies in Thermal and Oxidative Polymerization of Semi-Drying Oils.

K. K. Dole *and* N. R. Aphale, Poona.

Thermal polymerization of Arachis, Niger seed, Sesame and Safflower seed has been studied by heating the oils in an inert atmosphere at different temperatures and different periods. Oxidative polymerization of these oils has also been studied by heating them at the same temperatures and periods but in presence of a current of dry air. Iodine value, refractive indices and molecular weights are determined in each case. The molecular weights are determined by cryoscopic methods in benzene. Molecular weight increase in oxidative polymerization is always more than in thermal polymerization. Refractive indices are increasing with increase in polymerization and are approximately proportional to the increase in the molecular weights. Iodine values naturally decrease but no correlation exists in the iodine values and the corresponding molecular weights. It seems that some correlation may seem to exist if the study is extended to longer ranges of temperature and time of heat treatment.

124. Studies in the Preparation of Aluminium Solder.

D. R. Dhingra, G. N. Gupta *and* M. G. Gupta, Kanpur.

Since the introduction of aluminium as an important engineering material, much time and energy have been spent in developing methods for making joints of the metal and its alloys. At the present time the usual methods employed in practice are oxy-gas welding and soldering. Inspite of the extensive research-work as yet no solder has been discovered which would make permanent joints and could stand long exposures to moist atmospheres.

Detailed investigations were made to prepare an aluminium solder which would make strong joint and have minimum electrolytic action. As a result of these experiments it has been possible to prepare an aluminium solder which works smoothly, has a melting point of about 320°C and produces end to end joints which could bear a stress up to 7.5 lbs. sq. in. This is an improvement over one of the best foreign solders the end to end joint with which could bear a stress only upto 7.1 lbs. sq. in.

This solder did not require any flux, the joint could stand corrosion in 10% salt solution for more than two months and remained unaffected in boiling water for more 60 hours. The composition of this solder is as follows:—

$Al = 6.5\%$, $Sn = 47.5\%$ and $Zn = 46.0\%$.

125. Organolite from Indian Tannins.

M. S. Bhatnagar *and* B. P. Singh, Kanpur.

The present work was undertaken to prepare ion exchangers from cutch which is largely available. Analysis of various samples of cutch was carried out and they were found to contain about 8% insoluble matter. This was removed and the rest was resinified. The following results were obtained.

1. It did not adsorb strong acids.
2. It gave colour with strong alkalies.
3. The adsoprtion of calcium, barium, strontium was studied.
4. The adsorption of $Ca(OH)_2$, $CaCl_2$, $MgCl_2$, $MgSO_4$ was also studied.

It was observed that calcium was adsorbed more as hydroxide than as chloride and magnesium was adsorbed more as sulphate than as chloride.

126. Production of Saltpeter in the Hyderabad State.

D. S. Datar, Hyderbad-Deccan.

Saltpeter as a natural mineral deposit does not occur in the state. It is, however, manufactured in certain villages in the south western part of the state from the earth taken under old refuse heaps. The earth containing on an average 3-5% of potassium nitrate is extracted with water. About 40-50 tons of shora are produced annually.

A sample of shora or crude saltpeter from Gulbarga District contained 70.5% potassium nitrate and 26.7% sodium chloride. The crude material can be refined by throwing it into a boiling saturated solution of sodium chloride. The refined salt contianed 95% potassium nitrate. Common salt is a bye product.

127. A note on the Development of the Potash Production in Hyderabad.

D. S. DATAR *and* S. HUSAIN ZAHEER, Hyderabad-Dn.

Potassium salts are valuable fertilizers. The present production of potassium salts in the Hyderabad State is meagre. A few tons of saltpeter are recovered from the earth taken from under old village refuse in certain localities, which are utilized locally for making fireworks The other potash bearing minerals existing in the state are felspar and waste mica. Economic methods for the recovery of potash from them are under investigation. The other important source of potash is the waste materials in certain industries, which contain considerable amount of potash. It is estimated that annually about 300 tons may be recovered from the waste from the manufacture of alcohol and about 800 tons from the fine dust in the cement industry. The fine flue dust is now allowed to escape to the atmosphere. The cement factory will have to fit up the necessary equipment for the collection of the fine dust. The another source of potash is wool yolk obtained by washing raw wool. This is estimated to yield about 50-100 tons of potash annually. The other sources of potash are the waste from the tobacco industry, cotton hull ash and wood and kitchen ashes, which are used directly as fertilizers. The utilization of these potash bearing ashes and other village refuse as fertiliszrs should be organised on rational and standardised basis. The recovery of potash from industrial wastes and other potash bearing materials must receive our immediate attention to enable us to cope up with the demand for the potash fertilizers.

128. Development of the Salt Industry in Raichur and Gulbarga District.

D. S. DATAR, Hyderabad-Dn.

Edible salt is made in the western districts of the Hyderabad State from salt earth and brine from wells. The salt when contaminated with sodium sulphate and magnesium sulphate is known as tannery salt as it is used for preserving raw hides and skins. This is better and unfit for human consumption and is sold at cheaper rates. A process has been developed for the recovery of the different salts in the tannery salt, which consists of (1) the precipitation of magnesium as basic magnesium carbonate, (2) freeing of sodium sulphate from boiling solution taking advantage of the lower solubility of sodium sulphate at higher temperature and (3) separation of sodium chloride by throwing tannery salt into the solution made saturated with respect to sodium chloride after removal of magnesium and sodium sulphate. This solution can take up more sodium sulphate and magnesium sulphate but throws out sodium chloride. The basic magnesium carbonate may be converted into magnesium sulphate by heating it at about 300°C with coal pyrites. It is estimated that more than 400 tons of table salt and 150 tons each of sodium sulphate and magnesium sulphate can be recovered from the tannery salt.

A mixture of sodium chloride and sodium sulphate, which is obtained after removal of magnesium from tannery salt, may be used in the hydrochloric acid industry in the State to replace the imported common salt.

129. Durability of Soda-Lime-Silicate Glasses.—Part V.

A. CHOWDHURY (Calcutta) *and* H. N. DAS-GUPTA, Dhanbad.

A Study of the effect of Ultra-Violet radiations of both long and short wave lengths on chemical durability of glass has been made. It has been found that these exposures bring about changes in the constitution of glass. The alkali ions are the most loosely bound units of glass structure, and the change, referred to above, relates to a general strengthening of such bonds. This results in an increased durability of the glass. Thus, if the chemical resistivity of the bulk of the glass be determined by using a "powder method", the Chilled glasses show distinctly lower resistivities than the same glasses after exposure. In this respect the effect appears to be analogous to that of annealing.

130. Recovery of Sulphur from Copper Pyrites.

M. R. BASU *and* H. N. DAS GUPTA, Dhanbad.

Results of preliminary laboratory experiments suggest the possibility of recovering the sulphur from copper pyrites, either as the element. or in the form of ammonium compounds. The process too appears to be a simple one. This consists in evolving the sulphur as sulphuretted hydrogen, or as a mixture of sulphuretted hydrogen and sulphur dioxide, and contacting the evolved gas or the gaseous mixture with oxides of nitrogen. In the former case immediate deposition of sulphur takes place, and, in the latter case a mixture of ammonium sulphate and sulphite is produced.

131. Glasses Containing High Percentage of Phosphoric Anhydride.

P. D. SWAMI, Bikaner.

The aim of the present investigation was to study the various phosphate glasses as regards their deformation temperatures and to find, if possible, some suitable composition containing as high a percentage of phosphoric anhydride as practicable and maturing at 1650°F, which can be used as a ground coat enamel on steel.

Ortho-phosphoric acid was used with some difficulty as a source of phosphoric anhydride, but mono-ammonium dihydrogen phosphate was found to be much more satisfactory.

Fifty-two compositions were studied and the deformation temperatures of the resulting glasses determined.

It was found that excess of phosphoric anhydride and lithium oxide in the glass causes bloating in button tests; furthermore, the excess of phosphoric anhydride renders the glass unstable and thus unsuitable for use as enamel. Substitution of barium oxide for phosphoric anhydride eliminated bloating.

Composition which most nearly meets the object of this investigation is as follows:

20% P_2O_5; 25% SiO_2; 15% B_2O_3; 6% CaF_2; 20% BaO; 5% Al_2O_3; 5% K_2O; 1% Co_3O_4; 1% NiO; and 2% MnO_2.

The enamel having this composition deformed at 1650°F without any bloating. It is promising for use as ground coat enamel for steel. Preliminary tests showed, however, chipping and crazing when fired.

132. Utilization of Hyderabad Coal Pyrites. Part I. Preparation of Calcium Hydrosulphide and Sodium Sulphide.

D. S. DATAR, Hyderabad-Deccan.

Calcium hydrosulphide and ferrous sulphate are the two valuable and useful products obtained when the following process is employed:—

$$\text{i)}\quad FeS_2 + CaO + C \xrightarrow[\text{3 hours}]{\text{600-800°C}} FeS + CaS + CO$$

$$\text{(ii)}\quad \frac{FeS + CaS}{\text{from (i)}} + \frac{H\ S}{\text{from (iii)}} \rightarrow Ca(HS)_2 + FeS$$

$$\text{iii)}\quad \frac{FeS}{\text{from (ii)}} + H_2SO_4 \rightarrow FeSO_4 + H_2S$$

The yield is over 90%

Sodium sulphide is produced by the reaction between iron pyrites and sodium carbonate in presence of coal. The yield is 32% when equimolar quantities are used. The yield is 60% when the mixtures of iron pyrites and sodium carbonate in the molar proportion of 1: 2 or 1 : 4 are heated at 900°C for 3 hours.

133. Utilization of Hyderabad Pyrites. Part II. Preparationof Sulphates.

K. N. MOORTHY, D. S. DATAR *and* S. HUSAIN ZAHEER, Hyderabad-Deccan.

Reaction of iron pyrites with metallic oxides and carbonates have been employed in the preparation of the sulphates. Good yields have been obtained in the ccse of magnesium sulphate, sodium sulphate and manganous sulphate. Investigation is also in progress on the preparation of sodium sulphate from sodium chloride by a modified Hargreaves' Process.

134. Refrigeration in Aid of Steel Industry.

J. R. BASU MALLIK.

In this paper, the author has reviewed the results obtained by the use of oxygen-rich air in the iron and steel industry.

In the first part, the author has described the various methods of liquefying air and the subsequent production of gaseous oxygen from the liquid air.

In the second part, the author has shown the results obtained by the use of oxygen rich blast in the production of pig iron. The experiments carried in foreign countries indicate the possibility of utilising the low grade ore and coal economically. The greater output and saving in coke consumption, justify the capital expenditure for the production of gaseous oxygen

Results of the use of oxygen—rich air in the production of steel are also very encouraging. The main advantages are:—1) Greater output. 2) Better grade steel. 3) Use of larger percentage of scrap.

135. A New Type of Grinding Aid in Disintegrations of Solids.

K. K. MAZUMDAR, Dhanbad.

A new type of grinding aid has been found very efficient in grinding tough substances, e.g. flaky graphite. They are minerals of great hardness and high magnetic permeability e.g. ilmenite, magnetite, rutile, etc. and afford ready means of separation from the material ground by an electro-magnet from suspension in water. They form a distinct class and their uses for the above purposes have not yet been reported.

136. Influence of Physico-Chemical Properties of Brick-Earths on Fired Bricks.

N. K. PATWARDHAN, Roorkee.

As a result of an exhaustive study undertaken at the Building Research Unit (C.S.I.R.), Roorkee (U.P.), on the Physico-Chemical properties of Bricks Earths and Bricks from different parts of India some useful information has been collected. It has been found that on acount of heterogenity of brick earths the study has to be carried out on the same lines as in the case of agricultural studies on soils. The result in order to be of any practical value ought to be statistically examined. Of the many properties studied it appears that the mechanical composition, firing temperature and the presence of fluxes in the earths influence the finished bricks considerably. The geological age of the deposits is of great importance and as a general rule it can be said that those of recent geological age give good products.

137. Beneficiation of Low Grade Manganese Ores.

K. K. MAJUMDAR, Dhanbad.

Manganese ores from Gadshanker mines, Patna State, having the composition (Insoluble 14.17%, Mn 30.61%, Ba 1.00%, Fe 26.80%) were subjected to sink and float operation without success. It was also not possible to improve the grade by froth flotation with oleic acid and pine oil at pH 4 to 6 and also with Na-oleate and pine oil at pH 8 to 9.

138. Beneficiation of Lead-Zinc Ore from Zawar, Rajputana.

K. K. MAJUMDAR, Dhanbad.

Lead-zinc ore from Zawar, Rajputana, responds excellently to sink and float process, thus making it possible to discard a large amount of gangue, in the coarse state. Results obtained with the average run-of-mine ore are as follows ;—composition of run-of-mine ore, insolubles 19.92%, Pb 12.60%, Zn 10.23% ; size of ore particles-¼-10 mesh ; yield

55%; composition of concentrate, insoluble 9.48%, Pb 9.55%, Zn 16.34%; recovery Pb 86.06%, Zn 93.10%.

139. Determination of Chlorine Linked to Organic Compounds in Coal.

J. N. CHAKRABARTI, K. K. MAJUMDAR *and*
H. N. DAS GUPTA, Dhanbad.

It has been found that Meulen's method (Rec. trav. Chim., 1928, *47*, 698) is quite suitable for estimating the percentage of chlorine, linked to organic compounds, in coal.

140. Simultaneous Determinations of Total Chlorine, Nitrogen and Phosphorus in Coal.

J. N. CHAKRABARTI, K. K. MAJUMDAR *and* H. N. DAS GUPTA, Dhanbad.

The department of Scientific and Industrial Research, Lond., has recommended standard methods of analysis of Coal and Coke for its Fuel Research Station. In fact, these methods have got wide popularity. It appears, however, that some of these methods are time consuming and are not beyond criticism. Thus, for each ingredient a separate experiment has got to be made. The determination of Chlorine entails a period of 25-26 hrs. Again, in the determination of phosphorus in Coal, the latter has got to be exposed to a temperature of 775°+250°C to get its ash. The ash thus obtained is used for phosphorus determination. In this case an assumption has been made that no phosphorus is volatilised during the preparation of ash. Conditions favourable for expulsion of phosphorus are prevalent during ash formation and, as such, there can hardly be any justification for the above assumption.

A new method has been envolved for estimating the percentage of chlorine, phosphorus and nitrogen in Coal. This consists in subjecting coal to moist combustion, when both chlorine and phosphorus are completely expelled from their original combinations. The evolved products are quantitatively absorbed in a solution of sodium hydroxide, containing an equl volume of hydrogen peroxide. The resulting solution is then utilised for determining the proportions of chlorine and phosphorus. The nitrogen of Coal remains in the digestion vessel and a measure of which is easily obtained by expelling it as ammonia. The total digestion period is between 50 and 55 minutes. The process also offers additional advantage of determining the ingredients of coal ash in the same set of experiments.

141. A Comparative Study of the Methods for Determining Unsaturation in Drying Oils with Particular Reference to Conjugated Double-Bonds.

S. M. DAS GUPTA *and* R. C. DAS GUPTA, Delhi.

During recent years, when drying oils containing conjugated double bonds, either natural or artificial, have found increasing applications in protective coatings on account of their capability of undergoing the Diels-Alder reaction, it has been engaging the attention of the chemists to find out a reliable method for the determination of such unsaturation. In this paper, a comparative study of the current methods for determining unsaturation in drying oils with particular reference to conjugated double bonds, has been made under the same conditions. Four methods were selected : (1) Wijs' (partial iodine absorption method); (2). Hoffmann and Green's modification of the standard Wijs; (3). Kaufmann bromometric method; (4). Woburn method. The experimental results obtained led to the following conclusions: (1) In the case of non-conjugated oils, Wijs, Hoffmann's modification of Wijs', Kaufmann, and Woburn methods give an increasing order of iodine values; (2) In the case of conjugated systems, the Woburn method gives much higher figures than the Wijs'; Kaufman figures lie in-between these two methos; (3) The difference between the iodine values obtained by the Woburn and Wijs methods is an approximate measure of the diene value; (4) safflower and menhaden oils which are at present believed to be non-conjugated oils, also contain small amount of conjugated fatty acids; (5) although the naturally accurring conjugated tung oil gives almost the theoretical maleic anhydride number, the artificially made conjugated oils g ve low figures. The type of conjugation in these latter oils either exists in a pseudo form or offers some steric hindrance to the Diels-Alder type of reaction.

142. A Review of a Method for the Evaluation of Paint Films Under Various Weathering Conditions.

S. M. Das Gupta *and* K. K. Puri, Delhi.

The final rating of an organic film from a study of its outside exposures under various weathering conditions such as light, humidity, and temperature changes, is an important problem for the paint industry. It is also important from the view point of national economy. The subject, however, is complicated as it involves several factors. In this paper, a method is suggested which may be of value in correlating different types of failures by one single all-inclusive figure. After careful scrutiny, paint faliures have been classified into six groups and indicated by 0, 2, 4, 6, 8, 10, according to the degree of failure. 10 indicates perfect and zero (0) indicates complete failure. Photographic pictures of degrees of failures of each type have been published by the Federation of Paint & Varnish Production Clubs (U.S.A.). With the help of these pictures, film can be compared for various types of failures such as checking, cracking, peeling etc., and quantitative values assigned for each type of failure. The final assessment of the paint film by one single figure may then be made with the help of a nomograph designed by Garlock & McMullen.

143. Analysis of Vanaspati imported to Orissa.

D. Mishra, Orissa.

Most of the people in Orissa believe in genuine ghee and genuine oil but not in Vanaspaties. Some of the Vansapaties imported here are utilized in adulteration of ghee due to the mal-practice of the ghee dealers. In comparison to ghee the consumption of Vanaspaties is much less in Orissa. The total output of ghee in Orissa is 95,000 maunds and the total import of Vanaspaties in 1946-47 was 5,000 maunds and in 1947-48 was 6,000 maunds. The following Vanspaties are imported to Orissa—a) Dalda, b) Rasoi, c) Rakav, d) I.V.P., e) Bansada, f) Kusum Product, g) Lion brand, h) Krishna brand, i) Lakshmi brand, j) Kamdhenu. The Department of Food, Government of India, in their notification dated 31st January, 1947 gave the specification for Vanaspati. It was formerly thought to be akin to Margarine and the probable constituents were as given in proceedings, Indian Science Congress, 36th. abstract, p. 91-178. But qualitative tests and a few chemical tests clearly show that most of them contain Cocoanut, groundnut, Cottonseed and Sesame oils. But some of them correspond to the values of Mahua oil. Out of all the Vanaspaties b) Rosoi, c) Rakav, d) I.V.P. e) Bansada, f) Kusum products, g) Lion brand were analysed and found almost akin to Dalda Vanaspati according to the experimental results given in orginial paper.

144. Grit in Atta and Flour—Utility of Carbon tetrachloride Test.

S. K. Bhattacharyya *and* S. N. Mitra.

In routine examination of atta and flour it was observed that presence of excessive extraneous grit and sand made these otherwise fit commodities physically unfit for consumption, apart from their being injurious. As a large number of samples were daily examined, we felt the necessity for a rapid test for detecting extraneous sandy matter and to fix its upper limit in atta and flour.

"Ash%" alone could not afford definite conclusion as samples having normal ash contents had, not infrequently, too high a percentage of grit. For initial rapid sorting carbon tetrachloride was used to cause the sample to float on top and to throw down the sandy matter at the bottom. If the amount of the latter was appreciable, estimation of "Sand or Siliceous Matter" was done.

From a large number of such analyses we were able to fix the upper limit for extraneous sandy matter which would be 0.25% for atta and 0.20% for flour. Beyond these limits the grit "tells between the teeth", more so as its amount increases. Use of carbon tetrachloride was further extended to detect and identify mineral additions in self-raising flours.

145. A New Volumetric Method for the Estimation of Citric Acid.

D. S. Datar *and* V. D. Thatte, Hyderabad-Dn.

The reaction between Potassium permanganate and Citric Acid in presence of Sulphuric Acid is induced by Ferrous Sulphate. This reaction has been employed for the determination of the strength of Citric Acid. This is done by titrating it against Potassium permanganate in the presence of acidified Ferrous sulphate.

146. Oil-Base Drilling Fluid.

S. N. Biswas *and* N. C. Sen Gupta, Digboi.

In rotary drilling of oil-wells a fluid, generally a suspension of clay in water, is circulated through the dril-pipes carrying the rock cutting to the surface. Water-base muds have, however, the disadvantage that water is filtered from the mud into the porous rocks. This water reduces the permeability of the sand to oil and, in certain circumstances, may entirely prevent flow of oil into the well. Oil-base muds are now being used where there is likelihood of loss of production due to this effect of water. For the past year chemists of the Assam Oil Co. have been conducting experiments on the preparation of Oil-base muds from local products. A practical trial using oil-base muds has recently been made in one well to drill through low pressure oil sands; the production obtained was markedly better than estimates for wells using water-base muds. The viscosity and other desirable characteristics of the fluid were controlled by adding to the oil requisite amounts of blown bitumen, a vegetable oil and caustic soda. Specific gravity of the fluid was increased to the desired value, by adding finely ground barytes. Laboratory experiments are being continued to use a loading material lighter than barytes.

147. A New Oxidising Agent for the Bleaching of Textiles.

B. R. Walavalker, P. R. Bavdekar *and* R. P. Daroga.

The present paper is limited to a summarised presentation of the properties of the new product, calcium chlorite $Ca(ClO_2)_2$, in order to indicate or suggest its unique adaptability to many industrial uses. Calcium chlorite has very high oxidising power to destroy all the colouring matter associated with cotton fibre but it is not powerful enough to attack the fibres themselves.

Further research work carried out during the past year by the Research Department of Tata Chemicals Limited has shown that excellent results are obtained, without altering ordinary bleaching procedures in any particular way, if a mixture of calcium chlorite and hypochlorite in an alkaline solution is used in the place of straight hypochlorite. The bleaching action of this mixture is that of chlorine-dioxide (ClO_2) and not of hypochlorite. The results show that the cloth is bleached faster and somewhat better white colour is obtained than ordinary straight bleaching. When the mixture is used, only from one-half to two-thirds of the total available chlorine used in the straight hypochlorite bleaching is required.

148. Inducing Flowering in Mango by Ringing the Bark.

P. C. Mallik, Sabour.

To determine how far ringing can induce flowering in mango and whether the treatment can be used as an orchard practice to encourage blossoming in the 'off' years, experiments have been conducted at Station. It has been seen that ringing the main branches can induce flowering in 'off' years and increased flowering in 'on' years, in young and older trees alike. Trunk ringing is detrimental even when applied in two halves. Ringing the branches in early August is better than mid-August or early-September treatments.

Out of the three widths, viz., ¼", ½" and ¾" employed, ½" ringing is most effective; ¾" is injurious as the wounds do not heal up for along time, and do not give the desired effect while ¼" rings heal up before the effect is fully achieved. Half inch rings however show an adverse effect on certain percentage of ringed branches but this can be successfully averted by manuring the reated plants with F.Y.M. Am. Sulph. immediately after the treatment. The various effect were more pronounced in the 'off' years than in the 'on' years when the results are partially masked. Ringing in successive years can be practised with advantage. Effcet of ringing is immediate during the next bloom and no residual effect remains in the year following. Shy bearers could easily be forced to bear by ringing even earlier.

149. Fixation of Nitrogen by Vegetable Oils.

S. A. Saletore *and* V. N. Gavai.

Samples of groundnut oil, whether raw, refined or bleached, when exposed to the air for long periods of time under room conditions have been found to show an increase in their nitrogen content. Accelerated tests carried out by bubbling air at 95°C through groundnut oil, the distilled esters of its fatty acids, cocoanut oil and linseed oil show similar increases but at more rapid rate. The authors believe that this increase in nitrogen content is due to fixation of atmospheric nitrogen by the oils, which phenomenon does not appear to have been observed uptill now.

It has also been noted that in the case of aeration of oils organoleptic rancidity develops at a certain stage, which corresponds more closely with the nitrogen content than with the peroxide value. Nitrogen gas by itself also gets fixed by oils, though in the absence of oxygen this does not cause any rancidity.

The smell of rancidity caused by air containing both nitrogen and oxygen is different from the smell produced by the action of oxygen only.

150. A Note on Vegetable Oil and Alcohol Mixture used as a Fuel Oil.

S. S. Joshi *and* S. Husain Zaheer, Hyderabad-Deccan

A mixture of groundnut oil and alcohol containing 10 to 12 per cent of alcohol was used in diesel oil engines. An addition of 0.5 to 1 percent of ether sulphuric removed the difficulty in the starting of the oil engine which was experienced with the above mixture, the mixture was satisfactory in all respects except that the engine required frequent cleaning to remove the deposits of carbon residue in exhaust lines. The mixture of winterised mowhra oil and alcohol in about the same proportions as above was found equally satisfactory

151. Properties of Fatty Esters.—Part I. Comparative Surface Activity and Wetting Power of Monoglycerides from Different Oils.

K. Rama Varma, Tatapuram.

Monoglycerides are surface active agents of the nonionic type. Due to their surface activity they are excellent emulsifying agents. They also possess significant wetting property.

A comparative study of the properties of monoglycerides prepared from three oils was made in respect of their surface tension and wetting power. The former was tested by a stalagmometer while the latter was done by the Drave's test and the canvas disc method. It was found that there is no direct relation between the surface tension of its solution and its wetting power.

It was also observed, from these tests, that monoglyceride perpared from cocoanut oil is superior to either Groundnut or Castor oil derivatives as regards their wetting properties.

152. A Method for Quick Extraction of Glue from Bones.

K. N. Murthy *and* S. H. Zaheer, Hyderabad-Deccan.

A method for quick extraction of glue from bones is described. The bone meal after removal of glue is as good a fertilizer as super phosphate of lime.

153. Evaluation of Decolourising Carbons.

K. S. G. Doss *and* Ajit Singh, Kanpur.

A method for evaluating decolourising carbons has been evolved, fulfilling all the necessary conditions for getting reliable results. It is found that when the necessary precautions are taken, the colorimeter can be used for absorption measurements involving caramel solutions.

154. Preparation of Active Carbon

N. V. Joshi *and* R. D. Vokil, Poona.

Preparation of active carbon was carried out with different oil seed husks such as Safflower, groundnut, Undi and also with Date seeds etc. The effect of various concentrations of $ZnCl_2$, $CaCl_2$ anhydrous $MgCl_2$ and NaOH on the materials from which activated carbon was to be prepared and also the effect of heating the carbon to different temperatures on its properties was studied.

The data presented on the different activated carbons prepared by various methods named above from which it appears that in the case of activated Carbon prepared from Safflower husk a descending order of activity was found with the treatment of the husk with $ZnCl_2$, anhydrous $MgCl_2$ and $CaCl_2$ in the test for examining the activity of the carbon for the adsorption of Methylene blue and Iodine.

155. Influence of Chemical Treatments on the Adsorptive Properties of Activated Charcoal: Adsorption Isotherms.

SUDHAMOY MUKHERJEE *and* SUKHAMOY BHATTACHARYA,
Calcutta.

The adsorption of methylene blue, iodine and acetic acid by a number of charcoals, prepared under different conditions, has been studied at various concentration of the adsorbates.

The adsorption, in general, is found to obey the Freundlich isotherm and straight line curves are obtained on plotting log a against log c. For the adsorption of methylene blue and iodine, zinc chloride-activated charcoal is more active than that activated with calcium chloride, sulphuric acid or caustic soda. The activity of the former, in respect of methylene blue, iodine and acetic acid, is increased by further treatment with solutions of oxidising substances, namely, potassium permanganate, dichromate and persulphate, bromine and perchloric acid. The adsorption of iodine by non-treated charcoals tends to fall at higher concentrations and this is more pronounced in the case of the non-activated charcoal.

The variations in the slopes and intercepts of the adsorption isotherms have been discussed.

156. Influence of Oxidising Agents on the Adsorptive Powers of Charcoal Part III. Bromine, Perchloric Acid and Potassium Persulphate.

SUDHAMOY MUKHERJEE *and* SUKHAMOY BHATTACHARYA, Calcutta.

The treatment of activated charcoal with aqueous solutions of bromine, perchloric and potassium persulphate, as a rule, results in an initial increase of the adsorptive powers with the concentration of the reagents and then a decrease at higher concentrations. The maxima usually occur at the concentration 0.05 N. No such maxima are noticeable after the treatment of non-activated charcoal with these oxidising agents, although the adsorptive power for methylene blue and iodine increases considerably.

The oxidising agents undergo reduction during such treatments in different degrees, in the order : $K_2S_2O_8 > Br_2 > HClO_4$. The oxidation of charcoal becomes manifest in the evolution of carbon dioxide and in the formation of rducing substances (after treatment with persulphate).

The suggestion has been made that the treatment with a suitable oxidising agent, as a final step in the manufacture of activated charcoal by the zinc chloride method, would result in a charcoal of better adsorbing power.

157. Preparation and study of Active Carbon.

S. KRISHNASWAMY *and* S. K. NANDI, Bangalore.

In view of the increasing importance of charcoal as an industrial adsorbent, an investigation of the preparation and study of active charcoal has been undertaken. The carbonisation of the bases for the preparation of active charcoal was carried out in an electrically heated alloy steel furnace 3″ in diamter and 24″ in length. Tamarind seeds were chosen as the base in view of their hardness and compactness of structure. About 1 lb. of the seeds were put in the furnace in each charge and the amount of gas and pyroligneous acid obtained was measured. The pyroligneous acid was subjected to A.S.T.M. distillation tests. Both chemical and physical activation by using respectively different concentrations of zinc chloride and superheated steam at different temperatures were tried. The quality of the active carbon obtained was tested for apparent density, iodine and methylene blue adsorption and decolourisation of oil. The carbon obtained under optimum conditions compared favourably with the standard carbons of the market. Further work is in progress with other waste materials and also on evaluation of the different carbons obtained as gas adsorbents.

158. Active Carbon from Exhausted Tribulus Terrestris.

K. K. DOLE, *and* K. S. MOGHE, Poona.

Tribulus Terristris (Gokharoo) is well known as a diuretic and tonic and is used in Ayurvedic medicines in the form of Asawa, Arishta and solid extract. The exhausted drug was dried and carbonized in presence of zinc chloride of different concentrations. The residue was noted to give a large volume of combustible gas during the process of carbonization and gives a great promise as a raw material for laboratory gas. Best active carbons were obtained from this material with 150% zinc chloride.

Adsorption of Methylene Blue Mg/gram was 727
" Iodine " " 877
" Acetic acid " " 131

These carbons are best suited for iodine adsorption, giving the largest value of the carbons tested so far, in our investigations. Capacity of acid adsorption is found to increase by using lower concentrations of zinc chloride and higher temperature of carbonisation.

159. Active Carbon from Exhausted Glycyrrhizæ Glabra.

K. K. DOLE *and* K. S. MOGHE, Poona.

Residue from the decoction of Glycyrrhizae Glabra with boiling water was dried and used for the preparation of the active carbon. Primary carbon was prepared by heating the residue in tubes heated in electric furnace and then steam-activated. Similarly the activation was also brought about by treatment with zinc chloride solutions of different strengths. Best carbons were obtained by treating the waste material with 40% zinc chloride.

Adsorption of Methylene Blue Mg/g. was 953,
" Iodine " 619,
" Acetic acid " 151.

Steam activation at 800° C. for 4 hours gave acetic acid adsorption of 270 mg per gram of the carbon.

160. Active Carbon from Exhausted Rheum Emodi.

K. K. DOLE *and* K. S. MOGHE, Poona.

Drug Rheum Emodi is both used in Ayurvedic medicine and Allopathic remedies. In Ayurvedic medicines it is used in the form of water extract and the British Pharmacopœia prescribes the alcohol extract. The exhausted drug from both the sources is found to be useful for the manufacture of a very efficient active carbon. The exhausted drug was treated with different concentrations of zinc solutions, dried and carbonized at 400°C. Most efficient carbon was obtained by treating the material by 80% zinc chloride.

Adsorption of Methylene Blue Mg/gram was 1288,
" Iodine " 723,
Adsorption Acetic acid " 131.

With 100% zinc chloride one carbon gave the value of 1429 mg/gram with methylene blue and the material is being investigated thoroughly.

161. Active Carbon from Wood of Euphorbia Tirucalli.

K. K. DOLE *and* K. S. MOGHE, Poona.

Although Euphorbia Tirucalli is not used directly in any of the Ayruvedic medicines, its milk is used as an external remedy and for the preparation of some Bhasmas. However, it is well known that its wood gives a very soft variety of charcoal and was expected to give a good active carbon. This expectation was fullfiled and the best carbons were obtained by treating the powdered wood with 100 and 150% zinc chloride. The results are :

Adsorption of Methylene Blue Mg/gram was 983
" Iodine " 825
" Acetic acid " 111

It seems that the exhausted drugs yield good active carbons without any elaborate treatment because their cellulose structure is loosened and made porous during the course of their exhaustion either by boiling water or alcohol extraction. From the results so far obtained all the waste products studied in these investigations offer great promise for the manufacture of active carbons.

162. Alkaloidal Content of Hyderabad Nux Vomica.

S. HUSAIN ZAHEER *and* BALDEV SING, Hyderabad-Dn.

Strychnos Nux Vomica Seeds indigenous to Hyderabad State in abundant quantities have been analysed for its strychnine and total alkaloidal content for the first time. From the results of analyses, the total alkaloidal content is found to be 2.005% and strychnine content 1.06%. Strychnine content varies in different samples. The alkaloidal content though below B.P. standards is not so low as to make it commercially useless.

163. Utilization of Waste Products from Ayurvedic Pharmaceutical Industries.

K. K. DOLE *and* K. S. MOGHE, Poona.

In almost all districts of the Bombay Province there is at least one big manufacturing concern dealing with the Ayurvedic Pharmaceutical preparations. Plant products which are used for the manufacture of Asawas and Arishtas consist of the following plants: Terminatia Arjuna, Seraca Indica, Tibulus Terristris, Boerhavia Diffusa, Terminalia chebula, Emblica Officialis, Rheum Emodi, etc. The drugs are either extracted with water or in recent methods extracted with alcohol and the residue is thrown away. However, the residues thus discarded accumulate in large quantities and their utilization is contemplated in this paper. Some of the waste products are useful as fertilisers and some fibrous materials can be used for the manufacture of paper-board. It has been found that one of the best uses of these residues would be manufacture of activated charcoal from them. Very good activated carbons have been prepared from Tribulus Terristris, Rheum Emodi, Glycyrrhizae and Euphorbia Tirrucalli. During the preparation of active carbons some of these waste products gave out large quantities of combustible gases and phenolic tars which can be exploited for useful purpose. Waste of Tribulus terristris and Glycyrrhizae Glabra are found to yield especially large quantity of combustible gas. Work on estimating the calorific value of the gases and the fractionation of the tars is in progress.

164. A study of Tikshna-Loha (preparation of iron in Ayurved).

G. S. PENDSE, S. N. YERAVDEKAR *and* (Mrs.) G. G. KANE.

A good preparation of iron in medicine is still to be hoped for. Of the several types of iron preparations used in Ayurvedic medicine, one type—namely Tikshna-Loha was taken up for study. Several samples of this preparation which approached to the standards laid down in the Ayurvedic texts were taken up for the study as regards their chemical, physical and clinical properties. A comparison was also made of the chemical and physical properties of the standard and commercial samples. The clinical work on standard samples appears to show, that the preparations are fairly comparable in their therapeutic effect to Citrated Ferrous chloride B.D.H. and with an additional advantage of smaller dosage and absence of secondary ill-effects of iron therapy. The study is also hoped to be of immense use for standardisation of Tikshna-Loha.

165. Scientific valuation of Fire Woods- PartI.

C. C. SHAH, B. N. MANKAD, R. D. PATEL *and* H. V. AMIN, Anand.

An attempt has been made to study the calorific values of common and uncommon woods, with a view to evolve out a scientific procedure for fixing the prices of woods. From the result it is observed that

(1) The order of quality of wood based on traditional beliefs does not hold any good.

(2) The woods, even from uncommon trees which are not harnessed as fire-woods, possess very high calorific values.

(3) Eventually, the prices charged at present are arbitrary without any relation with the calorific values.

It is suggested that :—

(1) The valuation must be directly proportional to the calorific values read out from the graph for calorific value against moisture content.

(2) The use of uncommon wood materials with high calorific values should be encouraged in order to supplement the fire woods, which are popular and suffer from high pressure of demand.

166. Estimation of Beryllium in Indin Beryls by the Fluorometric method.

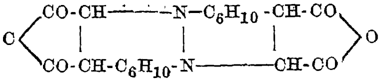
Miss. MONISHA BOSE, Calcutta.

Indian beryls have been examined for their Beryllium content by the fluorometric method developed by Mary H. Fletcher, White and Shefted (Ind.. Eng. Chem. Anal Ed. Vol.18, No. 3, 179-1946) using quinizarin in an alkaline citrate solution. The beryllium oxide content of the Indian ores from Ajmer have been found to vary from 12 to 13.5%. The results of the fluorometric method were checked by the chemical method and it was found tha the fluorometric method was accurate within 1%. The fluorometric method is of great advantage in routine analysis in as much as, it combines rapidity and simplicity with a fair degree of accuracy.

167. Reaction of Cyclohexanonazine with Maleic Anhydride.

D. B. DUTT *and* P. C. GUHA, Bangalore.

Aromatic aldazines react with maleic anhydride to give Crisscross adducts (Wagner-Jauregg, Ber., 1930, *63*, 322). Crisscross addition of cyanic and thiocyanic acids was extended to hydro-aromatic ketazines by Dutt and Guha (Curr. Sci., 1949, *8*, 297). Reaction of cyclohexanonazine with maleic anhydride has now been studied and it has been found that three types of products are formed depending upon experimental conditions : (a) In anhydrous benzene one molecule of azine reacts with two molecules of maleic anhydride to give the Crisscross adduct, 4,8-dicyclohexylidene-1, 5-diazobicyclo-(0, 1, 5)-octane-2,3, 6, 7- tetracarbonic anhydride (I); (b) in moist ether, equi-molecular amounts of azine and maleic anhydride react to give cyclohexylidene maleinhydrazine (II), and (c) in anhydrous benzene equi-molecular quantities give a resinous product.



(I)

C_6H_{10}=NH-CO-CH : CH-CO_2H

(II)

168. Studies in Sulfa-biguanides : Some N^4-substituted Biguanidyl-N^1-Benzoyl-sulfanilamides.

P. R. GUPTA *and* P. C. GUHA, Bangalore.

N^1-Benzoyl-sulfanilamide has been found to possess a very high antibacterial activity against certain strepto-and staphylo-infections *in vitro* by various workers (Sen Gupta, et. al. Ann. Biochem. Exptl.Med, 1946, *6*, 45; Bose and Ghose, Ind. Med. Gaz., 1949, *32*, 61). With a view to studying the effect of addition of biguanido grouping on this highly active sulfa drug it was substituted at N^4-position with aryl biguanide chains, and some N^4-biguanidyl-N^1-benzoyl sulfanilamides of type (I) have now been synthesised.

RNHC(=NH)-NH. C(=NH)-NH-C_6H_4. $SO_2NHCOC_6H_5$ Type I
where R=H, substituted aryl groups etc.

They have been prepared by refluxing N^1-benzoyl-sulfanilamide hydrochloride with the appropriate cyanoguanidines in pyridine medium and characterised as hydrochlorides. The following eight N^4-substituted N^1-benzoyl-sulfanilamides have been prepared :

1. N^4-biguanidyl-, m.p.240-241°(d)
2. N^4-(phenyl-biguanidyl)-, m.p. 264°-(d)
3. N^4-(*p*-chloro-phenyl-biguanidyl)-, m.p. 215-16° (d)
4. N^4-(*m*-chloropheny-biguanidyl), m.p. 239°
5. N^4-(*p*-bromo-phenyl-biguanidyl)-, m.p.266-68° (d)
6. N^4-(*p*-iodo--phenyl-biguanidyl)-, m.p. 230-2°(d)
7. N^4-(*p*-anisyl-biguanidyl)-,m.p. 213-14° (d)
8. N^4-(*p*-tolyl-biguanidyl)-, m.p. 225-6°(d)

169. Essential oil from the Wood of Lansium Anamalayanum Dedd. Isolation of new Sesquiterpenes.

K. B. Dutt, Sukh Dev *and* P. C. Guha, Bangalore.

The essential oil from the heartwood of Lansium Analmalayanum Bedd (Chigadmari oil) consists almost entirely of hydrocarbon constituents. By repeated careful fractionations through a partial condensation take off column, three distinct fractions have been isolated. These may be individual sesquiterpenes of unknown structure, and have been provisionally designated as Chigadmarene, Iso-chigadmarene and Neo-chigadmarene. All the three sesquiterpenes belong to the S-guaizulene type.

Chigadmarene, b.p. 140-142°/34 mm.; d^{28}, 0.8993; n^{28}, 1.4960 $(R_L)_D$, 66.2 $(R_L)_D$ for $C_{15}H_{24}F_2$, 66.14; $(a)_D = -203$ (1% $CHCl_3$ soln.); $(a)_D = -120$ (without dilution).

Iso-chigadmarene, b.p. 149-151°/34 mm.; d^{28}, 0.8941; n^{28}, 1.4950; $(R_L)_D = 66.56$; $(a)_D = -111.4$ (1% $CHCl_3$ soln.); $(a)_D = -66.8$ (without dilution).

Neo-chigadmarene, b.p. 154—157°/34 mm.; d^{28}, 0·8859; n^{28}, 1.4940; $(R_L)_D = 66.9$; $(a)_D = -63.3$ (1% $CHCl_3$ soln.); $(a)_D = -39.5$ (without dilution).

No crystalline derivative from any of these has been obtained.

170. Chigadmarene.

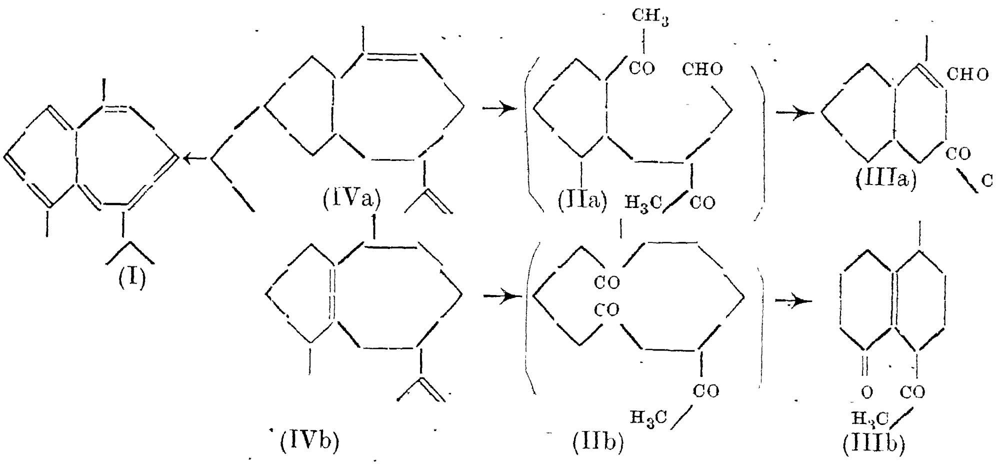
K. B. Dutt, Sukh Dev *and* P. C. Guha, Bangalore.

The molecular refraction of the sesquiterpene indicates that it is a bicyclic hydrocarbon with two double bonds. A titration with perbenzoic acid has confiremd the presence of the two ethylenic linkage.

The sesquiterpene cannot be reduced by sodium and alcohol and does not form an adduct with maleic anhydride. However it gives a positive colour reaction with diazotised *p*-nitro-aniline, which sometimes ndicates the presence of conjugation. But taking into account the other properties of the compound a pair of conjugated double bonds is not diagonosed.

The terpene on dehydrogenation with sulphur gives S-guaiazulene (I) which has been identified by the preparation of a picrate, m.p. 122. styphnate, m.p. 105-6°; T.N.T. compound 89.0° and T.N.B. compound, m.p. 151-2°. This reveals the carbon frame-work of the molecule.

In order to locate the two double bonds in the hydrocarbon, ozonolysis of the sesquiterpene has been studied. Formaldehyde is produced, which indicates the presence of at least one semicyclic ethylenic linkage. The other double bond appears to be endocyclic and is probably located in the seven membered ring, as a compound $C_{14}H_{23}O_2$ (III a or b) has been isolated amongst the non-volatile neutral products of ozonolysis. This product contains a double bond, reduces ammoniacal silver nitrate and gives a positive iodoform reaction. This is probably a secondary product of degradation, the primary product (II a or b) undergoing ring-closure. Such cases are not new in the terpene field. Taking into account all these points and other theoretical considerations only two structures (IVa, IVb) for the sesquiterpene are possible. Further work is in progress to definitely fix the structure.



171. Azulenes.

K. B. DUTT, SUKH DEV *and* P. C. GUHA, Bangalore,

New reagents for the isolation, characterisation and purification of azulenes have been developed. Of these picramide appears to be the most suitable. It very readily gives a complex with S-guaiazulene, which crystallises in stars of black needles from alcohol-acetic acid, m.p. 163.5°. Even from crude S-guaiazulene, a practically pure product is obtained which needs no further crystallisation. The azulene can be regenerated from the complex by a simple treatment with cyclohexane or light petrol.

Similarly picryl chloride gives black needles, m.p. 97-98°, of the S-guaiazulene addition compound.

172. Essential Oil from Atalantia Monophylla.

U. G. NAYAK *and* P. C. GUHA, Bangalore.

Studies on the essential oil ffrom the leaves of *Atalantia monophylla* have been completed. The oil has been shown to consist chiefly of *l*-sabinene (38%), *l*-linalool (14%); *l*-linalyl acetate (19%) and unidentified higher terpenes (29%).

173. Essential Oil vrom Hymena Therum Tenhifolium.

U. G. NAYAK *and* P. C. GUHA, Bangalore,

An essential oil from *Hymena Therum tenhifolium* has been isolated in a yield of 0.12% calculated on the fresh whole plant. The oil has the following analytical constants: d^{24}_{24}, 0.8130, $n^{24\ 5}$, 1.4712; $(a)_D^{25}$, -5.16, sap. value 20.97; sap. value after acetylation 83.9. The main constituent of the oil appears to be a new acyclic monoterpene, b.p. 94.5-95.5°/86 mm.; d^{25}_{25}, 0.8014; n^{25}, 1.4693; $(a)_D^{25}$, $-6.04°$. The terpene gives an adduct with maleic anhydride, m.p. 113-114°, and can be reduced with sodium and alcohol giving a dihydro-compound, b.p. 96.5-97.5°/70 mm.; d^{25}_{25}, 0.7849; n^{25}, 1.4500; $(a)_D{}^{25}_{25}-6.1$; bromo derivative, m.p. 63-64°, Further work on the elucidation of its structure is in progress.

174. Essential oil from Hyptis suaveolens.

U. G. NAYAK *and* P. C. GUHA, Bangalore.

A greenish yellow oil (d^{24}_{24} 0.8826, n^{25}, 1.4848; (a) $_D{}^{25}$, 4.1°; sap. value 6.23; sap. value after acetylation 49.35) has been distilled from the leaves of *Hyptis suaveolens*. The hydrocarbons have been identified as l-sabinene (31%), d-limonene (12.0%) and a sesquiterpene of the azulene group (12.0%).

175. Studies with Methone: Hydro-Acridones.

T. S. Sivaswamy *and* B. H. Iyer, Bangalore.

The N-methone substituted anthranilic acids reported last year were cyclised to the corresponding hydro-acridones.

The Clemmensen reduction of both the cyclised and the uncyclised products of anthranilic acid—methone condensation have been performed. In both the cases the products are the normal hydrogenated products, the CO-groups being converted to CH_2 groups. The compounds obtained melted at 240° and 100° respectively.

In the cases of condensed products, phenyl hydrazones, 2:4-dinitro-phenyl hydrazones have been prepared and identified.

Methone on dehydrogenation with sulphur has yielded two products melting at 125° and 204°. Characterization of these products is in progress.

176. Local Anaesthetics.

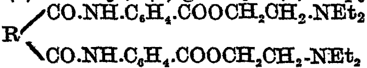
P. V. G. Krishnamacharyulu, B. H. Iyer *ond* P. C. Guha, Bangalore.

Several (10) urea, thiourea and guanidine compounds of novocaine have been prepared with a view to studying the effect of groups like (1) NH_2CONH,—, (2) NH_2OSNH-, (3) $-NH.C(=NH)$ $-NH_2$ and thier substituted derivatives replacing the NH_2 group of novocaine. Work on the preparation of biguanido, guanido-urea, and guanido-thiourea compounds of novocaine is in progress

177. Local Anaesthetics.

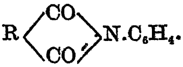
U. N. Narayana Rao, B. H. Iyer *and* P. C. Guha, Bangalore

With a view to studying the effect of acyl groupings added to the amino group of novocaine as local anaesthetic, compounds of the following acid-chlorides have been prepared; (1) Phosgene, (2) Oxalyl, (3) Malonyl, (4) Succinyl, (5) glutaryl, (6) adipyl, (7) Phthalyl. Compounds of the general formula



$$R\begin{cases} CO.NH.C_6H_4.COOCH_2CH_2.NEt_2 \\ CO.NH.C_6H_4.COOCH_2CH_2\text{-}NEt_2 \end{cases}$$

where R stands for such groups as $-CH_2-$, CH_2-CH_2-, etc.) have been obtained with 1-7. With 4 and 7, small quantities of compounds of the general formula



$$R\left\langle \begin{matrix} CO \\ CO \end{matrix} \right\rangle N.C_6H_4.$$

$COOCH_3.CH._2NEt_2$ (where R stands for $-CH_2-$ CH_2-, $-C_6H_4-$) have been obtained. Work on the preparation of corresponding acyl compounds from pyridine and quinoline carboxylic acids is in progress.

178. Condensation of Acetone with ethyl Nitroacetate.

D. B. Dutt, Bangalore.

In ethylnitroacetate, methylene group should be very active owing to the influence of the highly negative nitro and carbethoxy substituents, and hence should undergo condensation with carbonyl groups with the same ease as malonic, acetoacetic or cyanacetic esters. Moreover, the condensation products, owing to the presence of nitro group in alpha position to the carbethoxy, appear to be of promise as synthetic reagents to α-amino acids. With a view to studying the use of ethyl nitro-acetate as a reagent for amino acid synthesis, condensation with acetone has been tried, with methyl alcohol as solvent and sodium methoxide as condensing agent. Ethyl β-methyl-α-nitro vinyl acetate (b.p. 115-116/23-24 mm.) is obtained.

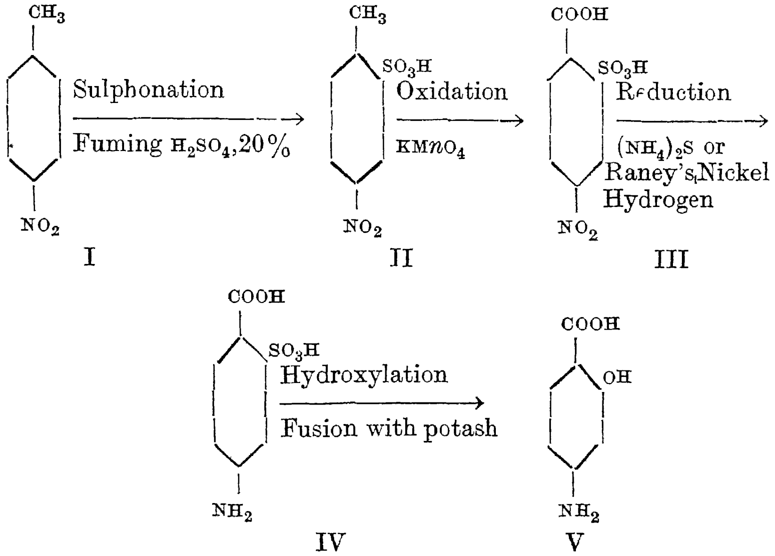
179. A new Synthesis of p-Amino Salicylic Acid.

M. Raghavan, B. H. Iyer *and* P. C. Guha, Bangalore.

p-Aminosalicylic acid which is now available commercially as its sodium salt under the trade name "PARAMISAN," has gained considerable importance in the chemotherapy of tuberculosis (Lehmann, Lancet, 250, 15, 1946; Youmans, Quart. Bull. North. Western. Univ. Med. School, 20, 420, 1946, cf. C.A. 41, 1011, 1947).

Clinical trials with the acid have amply shown that the acid which is well tolerated by man is remarkably effective in the treatment of pulmonary tuberculosis (D.D. Martin et al., Nature, 161, 435, 1948).

p-Aminosalicylic acid is prepared by a number of methods (Siedel & Biltner, Monatsh, 23, 423 1902; Ullmann and Wagner, Ann., 355. 360 1907; John T. Sheehan, J. Am. Chem. Soc. 70, 1665 1948; Erlenmeyer et al. Helv. Chimica Acta. 31, 988, 1948). Our method of synthesis of p-amino salicylic acid is as follows.



p-Nitrotoluene (I) was sulphonated to give 2-methyl-5-nitro benzene sulphonic acid (II), the potassium salt of which was oxidised with dilute potassium permanganate solution to the corresponding potassium salt of 4-nitro-2-sulphobenzoic acid (III). This on reduction with ammonium sulphide or with Raney's nickel and hydrogen gave 4-amino-2-sulphobenzoic acid (IV) which on fusion with potash yielded para-aminosalicylic acid (V) m.p. 145-146°. Yield 50%.

180. Preparation of Sulphuryl Chloride.

V. Lakshminarayana *and* B. H. Iyer, Bangalore.

A systematic study of the conditions for the preparation of sulphuryl chloride from sulphur dioxide and chlorine in the presence of camphor, activated charcoal prepared from coconut shell, paddy husk, wood and 'norite' as catalysts has been made.

A continuous laboratory method for preparing pure sulphuryl chloride has been described.

181. Investigations on the Ingredients of Wood Tar.

P. C. Guha *and* A. V. Kamath, Bangalore.

Bhadravati wood tar (84 lbs.) has been subjected to distillation and fractions coming at different temperatures separately collected, and their solubility in different organic solvents studied.

The fraction collected between 230-70° (about 45%) has been separated into the neutral, acidic and basic ingredients, the quantity of the last one being very small. The acidic portion has been subjected to fractional distillation and distillates collected at 10° range and then again at 5° range. By way of preliminary study, the presence of phenol, cresols, guaiacols, Pyrogallol dimethyl ether, xylenol, propyl guaiacol, has been established and confirmed by making known derivatives.

Experiments are in progress to isolate the ingredients in quantitative manner as far as possible, and to isolate compounds hitherto not described to be present in wood tar, by repeated fractionations and crystallisations.

182. Studies in Resins: Destructive Distillation of Rosin From Pinus Excelsa. Part I: Characterisation of the constituents from the neutral fraction of rosin spirit.

I. S. Patel, B. H. Iyer *and* P. C. Guha, Bangalore.

Although the chemical constituents of rosin oils from various American and French pine trees (mainly *Pinus palustris* and *Pinus maritima*) have been studied (cf. Kelbe, Ann. de Liebig, 1881, 210, 1; Renard, Ann. de Chimie et. Physique, 1884, p.223), the chemical constituents of rosin oil of Indian pine trees do not appear to have been studied so far. With a view to study the chemical constituents from *Pinus excelsa*, about 14 kg. of rosin was distilled and from the neutral fraction obtained after removing both acidic as well as phenolic components, the following compounds have been isolated and identified: methyl alcohol, 2-haxene, isobutyric aldehyde, methyl cyclohexane, toluene, p-xylene, cumene, pinene and *p*-cymene. Further work on the identification of the constituents from the higher boiling fraction is in progress.

183. Studies in Resins; Destructive Distillation of Rosin from Pinus Excelsa. Part II: Characterisation of the acidic constituents of Rosin Oil.

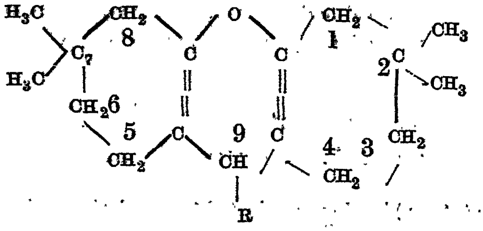
I. S. Patel, B. H. Iyer *and* P. C. Guha, Bangalore.

After repeated fractionation of the rosin oil, acidic portions were separated by shaking with 5% sodium hydroxide solution and subsequent neutralisation with dilute hydrochloric acid. From the various acidic fractions after careful fractionation using a fractionating column of the partial condensation take off vigreux type, acetic, propionic, isobutyric and isovaleric acids were isolated and characterised. From the higher boiling fraction comparatively larger amount of abietic acid was obtained.

184. Clemmensen Reduction of Aldimethones.

M. V. Kowjalgi *and* B. H. Iyer, Bangalore.

Dey and Linstead (J. Chem. Soc., 1935, 1063-5) obtained (1) 1, 1, 3-trimethyl-cyclopentane (2) 2, 4, 4-Trimethyl cyclopentanone by the Clemmensen reduction of methone, During this reduction the cyclohexane ring contracted to cyclopentane ring. With a view to studying the behaviour of some derivatives of methone during Clemmensen reduction a few of the aldemethones have been thus reduced and the products characterised as 2, 2, 7, 7,—tetra-methyl-1, 2, 3, 4, 5, 6, 7, 8, octahydro-9-alkyl (or aryl) xanthen, indicating that no reduction in the size of the ring takes place.



Condensation of methone with glucose could not be effected under the conditions tried.

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SECTION OF ENGINEERING AND METALLURGY

President: D. R. Malhotra, D Sc., A M.I.E., F.I.M., M.I.E., F.N.I.

1. Studies in Anti-fouling Paints: Part 1.

S. M. Das Gupta, Delhi.

Ship's bottom is covered by minute animal and vegetable organisms found in abundance in sea water, as soon as the ship is water-borne, unless its bottom and wooden hulls are painted with anti-fouling paints. The weight of fouling organisms removed from the bottom of the boats has been found to be to the extent of 100-200 tons in certain cases, and this dead weight causes an increase in fuel consumption to maintain a certain given speed by as much as·30%.

Anti-fouling paint contains toxic agents, copper flakes, copper oxide, mercury oxide, of very low water solubility, in a paint vehicle, the water premeability rate of which varies between 70-150 (Wray and Vanvorst method). Mica is very useful paint pigment, and dehydrated castor oil offers certain specific advantages not possessed by linseed oil.

The typical formulation of an anti-fouling paint is:—

Copper flakes 26.6%, Mica Powder 11.46%, Coumarone Resin 15.2%, modified castor oil (castung) 7.21%, mineral spirits 33.3%, driers (naphthenates) 0.16%, Pigment by volume 24.5 and weight per gallon 10.99.

2. Improvement in the Construction of Floors, Roofs, Walls and other structures and structural components made partly of concrete. Paper 1.

P. B. Ghosh, Sibpur.

The paper deals with economising the concrete in the building of the floors, roofs and walls, and other ctructures and structural components made of reinforced concrete by using burnt clay blocks of T and channel shapes.

3. Building Construction with T. Bricks. Paper II.

P. B. Ghosh, Sibpur.

The Author has worked out the construction costs both with rectangular bricks and T-& L-bricks with or without channels and shows that the constructions with T-& L-bricks are much more economical than with rectangular bricks upto the extent of 25-50% depending on the class of building.

4. Effect of Reflux Ratio and other Operating Variables on Packed Column Distillation.

R. L. Dasverma & S. K. Nandi, Bangalore.

The Authors have worked with ethanol-water system. Expressing column efficiency in terms of H.E.T.P., they found that H.E.T.P. increases:—

(1) With increase in distillation rate.

(2) With increase in feed concentration, and

(3) With decrease in reflux ratio.

R=L|D, where L is quantity of reflux flowing and D, the quantity of the product put back inside the still.

Further work is in progress with different concentration and different binary mixtures.

5. Upper Wind Observations with the Baby Maggie Radar and a Method of Adapting it to obtain upper winds by tracking the Radio-Meteorograh signaller.

B. K. GUPTA AND B. B. HUDDER, Poona.

Two types of targets, (1) Corner reflectors and (2) dipole, were tried. It was only possible to obtain a range of 16000 yds., but the long absence of the pip from cathod ray tube screen made an accurate minute to minute centering of the spot in the angle units impossible, and hence the idea of getting more range with fluctuating pip was given up.

Next the idea of using active targets like an oscillator generating 204 Mc|s (the frequency of the Radar) and following it with the reception side of the radar was taken up, and same signaller both for F. type radiosonde and also for radar wind finding was used.

The authors in their paper describe the construction of the oscillator, amplifiers of the signals and reception.

6. Study of Induced Voltage on a communication circuit under earth-fault conditions of a parallel H. T. Power Line.

H. N. SHRIVASTAVA, Delhi.

This paper gives details of an experimental investigation of the induced voltage on a telegraph wire carried on a line paralleling a 33 K. V. power line for 27.14 miles. An earth fault was produced at one end of the power line and oscillographic study of the voltage induced on the telegraph line made at the other end. The power line carries an earth wire of 0.042 sq. inches cross-section. There is an unbonded railway line running parallel to the telegraph posts about 24 ft. away on the opposite side. The screening effect due to this railway line is considered negligible. The induced voltage on the telegraph wire as obtained by this experiment is 25 per cent less than the theoretically calculated value. It may, therefore, be concluded that the screening effect due to copper earth conductor of 0.042 sq. inches cross-section on the power line is 25 per cent.

7. Niobium or Columbium.

N. R. SRINIVASAN, Bangalore.

The element of atomic number 41 is being referred in literature by the name Niobrium or Columbrium. Hatchett analysed columbite in 1801 and columbium was the name given to the new element, but Rose (1844) showed that what Hatchett considered an element was actually mixture of two elements, which he found tantalum (Eckberge 1802), and a new element which he named Niobium. Now the author contests that the nomenclature columbium be dropped and Niobium be adopted.

8. Flotation of Iron Pyrites from Mysore.

K. K. Majumdar, Dhanbad.

Extensive deposits of iron pyrites, sulphur content varying from 30-42.4%, have been discovered at Ingaldhal, near Chitaldrug in Mysore State. The author has experimented into the possibilities of beneficiating this ore by flotation.

Average run of mine ore having 36.98% S. was ground wet to 200 mesh and floated in a 1000 gms, Denver Sub-A Flotation Cell. Best results were obtained with K-ethyl Xanthate (0.1 Lb. per ton), eucalyptus oil (0.1 Lb. per ton), Copper Sulphate (0.05 Lb. per ton) at PM 5 to 6, and the recovery was 75%.

9. Economic Voltage for Transmission of Power.

C. S. Ghosh, Bangalore.

Use of higher voltages for transmission of large blocks of power over long distances has been the universal practice. It has, however, been found that the economic voltage of transmission does not vary very much, though the distance of transmission may be anywhere from 100 miles to more than 600 miles. Crary and Johnson in their paper on "The Economics of long distant A C. Power Transmission" have shown that for loadings of the above 200 MW the economic transmission voltage varies from about 287 KV to 360 KV. depending on the length of transmission.

The author gives an analysis of costs of transmitting various loads from 100 MW to 500 MW at voltage ranges from 100 KV to 400 KV and over distances ranging from 100 miles to 600 miles.

10. A Note on Binary Alloys.

K. C. Mazumdar, Jamshedpur.

The binary alloys of some metals like Cu, Ag and Au can be expressed by approximately definite chemical formula and are known as abnormal valency intermetallic compounds. The different phases of these alloy systems have definite electron-atom ratios which are generally expressed as 1.4, 3|2, 21|13, and 7|4 for a, B, r and e phases respectively. They can, however, be expressed more uniformly as 21|15, 21|14, 21|13 and 21|12. This regularity suggests the possibility of this being extended inside the a-phase also. The a-phase may, then, be composed of several minor phases of electron-atom ratios, 21|16, 21|17, 21|18, 21|19, 21|20, at the boundaries of which there will be discontinuities, however, small, of some physical properties of the alloys. The indications of such discontinuities found in the published data are discussed.

11. Corrosive Gases in Producer Gas.

Mohanlal Khanna, Delhi.

In India wood charcoal is generally employed for the production of producer gas, and it has advantage over other solid fuels such as authranite coal, soft coke, etc. in its low sulphur content and critical air blast value.

Anhydrous ammonia is not corrosive as it has been employed in Belgium for running vehicles.

Sodium Chloride when present in charcoal contributes to wear of engine. The estimation of water solubles and sodium chloride content in wood charcoal for use in gas producers for vehicles should be included in the standard testing procedure.

12. River Valley Projects & Food Production.

K. B. Ray, Calcutta.

In this paper various River Valley Projects planned by Central Waterpower, Irrigation and Navigation Commission (CWINC) are analysed. Shri A. N. Khosla, Chairman, CWINC, has stated that "barely 6% of the enormous water wealth is being put to beneficial use and the remaining 94% is permitted to run waste, frequently doing untold damage to life and property in its passage to sea". The author finds that the river valley projects are planned with the idea of utilising that 94% water for the canal irrigation and hydro-electric power production in the dam areas by constructing a number of dam in the course of rivers. On analysis of various projects he finds that this scheme will dry the rivers in their lower courses and monsoon floods will soon render the canals unserviceable, dams filled up, and therefore greater danger of flood devastation of the land and population will be created and food production is lost. He suggests that instead of adhering to the idea of utilising 100% water of the river water, it will do better if the Tennesse Valley project is strictly followed and accordingly he suggests:—

(1) After regulation at the dams the whole of the water be allowed to flow down the lower and tidal reaches.

(2) A uniform release of water will be possible at the dams throughout the year so that hydroelectric power is generated continuously to the full installed capacity of the power plant at the dams.

(3) This power is to be utilised for pumping water from tube wells for the irrigation of the land, and also for industrial purposes.

(4) Under such a scheme, the continuous flow of water assisted by River Training Works at certain intervals in the length of the river, will guide to a well-defined narrow and deep channel, and such a river can be utilised for navigation for its considerable length.

He further says that the river valley projects should be available to the public for study and they should not be treated as State secrets.

13. Cyclone-cum-scrubbing filters for Producer Gas.

S. K. Das Gupta & Mohanlal Khanna, Delhi.

Producer Gas as used in mobile producer gas plants is filtered through a series of filters using fibrous matter and textile fabrics, which remove solid particles, but tarry matter and corrosive gases are allowed to pass.

The authors give device, which is a combination of a cyclone and a scrubbing arrangement based on the counter current principle.

14. Steel Economy.

O. G. F. Paulssen &K. Ray.

The authors in this paper describe Shape Engineering and Light Structural Section in the light of Steel Economy.

15. The effect of Phosphorus in steel in time of rolling.

N. N. Rakshit, Tatanagar.

The author describes the effects of Phosphorus on the properties of steel.

16. Treated Wood as Structural Material.

S. Kamesam, Bangalore.

The author describes the various uses of treated wood and possibilities of replacing steel by wood.

17. Aluminium in Steel.

K. C. Mazumdar, Jamshedpur.

Inspite of its favourable size factor the primary solid solution of Al in the iron is very small; this is due to its strong electro-chemical factor. When the steel exists in this form the excess of Al is driven to the grain boundary and inhibits the grain growth. The electro-chemical factor makes it form radily the compound, FeAl, which has a body centred cubic structure. The grain of FeAl has a pronounced solubility in the iron; this is why only a single-phase is observed up to 50% Al added to the iron.

18. Laboratory Expriments on the Cleaning of Rewa Coals.

Prof. V. G. Iyer and K. C. Srivastava.

In this paper, the problem of cleaning high ashed Rewa Coal on a Laboratory Scale has been dealt with. The methods of cleaning and washing are detailed and a suggestion made to instal coal cleaning plants for improving these methods.

19. Utilisation of Fuel Wastes.

G. Ramarao, Hyderabad.

Large quantities of coal clinkers are thrown out as wastes from power stations. An attempt is made in this paper to utilise it as a substitute for concrete and sand in making cement concrete. The cement concrete so made is much lighter and cheaper than ordinary cement concrete. The crushing strength compares quite favourably with the latter.

20. Electro-deposition of Copper from Cyanide-Free Baths: Copper Oxalate-Monoethanolamine Solutions.

N. B. Shivaraman and T. L. Rama Char, Bangalore.

This investigation is concerned with the possibility of producing satisfactory electrodeposits of copper on steel, from solutions free from cyanides. Although cyanide baths have established themselves commercially, a search for substitutes continues, in view of the poisonous nature and the instability of these baths. The plating solution used in this work is very simple and consists of copper oxalate and monoethanolamine, a complex being formed in aqueous solutions. Like the low concentration cyanide-strike baths of copper, these solutions do not plate on steel by chemical displacement, in view of the very low concentration of free copper ions due to complex formation. Satisfactory deposits have been obtained and they are comparable to deposits obtained from cyanide baths. A study has been made of the effect of variation in (a) concentrations of copper oxalate and amine, and (b) current density. The cathode current efficiency is very nearly 100%. The addition or recholle salt has been found to improve the anode performance permitting higher current densities and lower bath voltage.

21. Calibration by Step-Filter and its use in the estimation of Mn, Si and V in High Speed Steels.

B. N. Bhaduri, M.Sc., D.I.C., Ph.D. (Lond.), Asstt. Physicist, New Control & Research Laboratory—Tata Iron & Steel Co. Ltd. Jamshedpur.

A new technique in calibration in steps with weighted manganese and their separation at fixed ratio was used for obtaining concentration-calibration curves for certain minor elements in high speed steels. As blackening curves obtained with plate calibration are not strictly parallel and separation as used for calibration purposes is taken arbitrarily at certain values of the densities following the slope of the curves it was found that one of the methods of eliminating errors in analytical works was by adopting the technique given. This itself is described in the text and the results obtained was found to agree with the chemical values as closely as can be expected.

22. Some Aspects of the Manufacture of Wheel Set Assemblies.

D. R. Dhanbhoora, Supdt. of Research, Tata Iron & Steel Co. Ltd. & S. Viswanathan, Asst. Supdt. of Research.

In the manufacture of wheel set assemblies a force fit procedure is employed for mounting the wheels on to the finished axles. The specifications relating to the manufacture of wheel set assemblies have been examined from the point of view of how far they are effective in determining the holding-on ability of the assembly. The theoretical basis of force-fit design has been discussed together with the various factors that determine the mounting characteristics. On the basis of a large number of tests the following conclusions have been reached:

1. The extent of plastic deformation during mounting is negligible.
2. The more important factors that determine mounting and demounting pressures are—
   - (*a*) Out of roundness
   - (*b*) Fit allowance
   - (*c*) Lubricant
3. The surface finish of the wheel bore and the relative smoothness of the two components are not of great significance.

23. A Method of Computation of field Harmonics in the air gap of an Electrical Machine caused by the permeance variation due to slot opening.

Dr. Mati Lall Jain, Calcutta.

In this paper the author gives a simple method to mathematically analyse the effect of slot opening on the permeance curve of the air gap in an electrical machine. The first step in the analysis consists in substituting a simple curve for the actual permeance curve obtained by F. W. Carter. The former curve, which is a close approximation to the latter, is then resolved into Fourier's Series. Then the effect of permeance variation due to slot openings on two types of sinusoidal M. M. F. waves-stationary and rotating—has been given. It is shown that in the first case the slot openings cause in the flux wave a series of space harmonic pairs which form beats with a beat period of the pole pitch, while in the case of rotating sinusodial wave the effect of slot opening is to produce in the flux wave a series of pairs of rotating waves, the members of each pair rotating in opposite directions.

The analysis can be easily extended to an M. M. F. of any complex wave shape.

Dr. Moti Lall Jain D.Sc. (Harvard), M.E.E. (Cornell), B.Sc. Hons. (E&M) Banaras, Assoc. Member of A.I.E.E., is a professor of Electrical Eng'g. at College of Engineering & Technology, Bengal. (Jadavpur).

SECTION OF MEDICAL & VETERINARY SCIENCES

PRESIDENT: DR. M. V. RADHA KRISHNA RAO, M.B.B.S., Ph.D., F.N.I.

1. Diagnosis of Early Vitamin Deficiency States.

M. B. DAVER, Hyderabad (Deccan).

1. When deficiency diseases are well established there is no difficulty in diagnosing them.

2. It is extremely difficult to diagnose early Vitamin deficiency states, as there is no specific methods for diagnosis and have to depend upon indefinite symptoms and signs found on physical examination.

3. Nutritional diseases and early deficiency states constitute a great medical problem from economic and disability point of view ; because it has been ascertained that not less than 75% human ailments may be attributed to early Vitamin deficiency state.

4. In early Vitamin deficiency states, laboratory tests are of little help. Nothing abnormal may be detected in urine, there may be no change in blood-picture. X-Ray examination of fractional test meal may reveal nothing.

5. Associated symptoms are often inter-woven and over-lapping and very often resemble the symptoms of neurasthenia.

6. It becomes very difficult to separate these two kinds of conditions.

7.. It is an established fact "some neurasthenics benefit by a properly balanced and forced diet. Thus one wonders what is more important, psychological treatment or proper food for their cure.

2. Nutritional Macrocytic Anaemias.

M. V. RADHAKRISHNA RAO and V. N. JAI, Bombay.

With the advent of newer therapeutic agents like Folic acid and Vitamin B12 in the treatment of Macrocytic Anaemias, considerable information is now available for a proper understanding of the aetiological factors associated with these anaemias. The present paper is a review of the recent work on the subject and gives an account of the authors' experience in connection with the diagnosis and management of cases of Tropical Nutritional Anaemias, commonly observed in the Relief Camps in Bombay.

3. A Field Investigation into Lathyrism.

M. N. RUDRA and L. KANT, Darbhanga.

The result of a field investigation into Lathyrism has been described and discussed 133 lathyrism cases were investigated and interrogated about their diets. Suggestions have been given for an all round improvement in the diets of the village communities where lathyrism is endemic. The evolution of an alternative hardy crop to Khesari is an urgent necessity.

4. Madura Foot (Mycetoma).

L. M. Ghosh, D. Panja & N. C. Dey, Calcutta.

Mycetoma or Madura foot is not common in Bengal. It is common in South India and Rajputana. The disease was known in ancient India as a separate clinical entity. The history is given in chronological order.

The organisms isolated from the two cases were identical. Both the fungi were studied and identified as actinomyces madurae.

5. Diet Survey in Indian Hospitals.

M. N. Rudra, Darbhanga.

A preliminary report on a Diet Survey carried out in the months of January, February and March 1947 in the Medical Ward of the Darbhanga Medical College Hospital has been given. It has been found that the intake of calories, and other nutrients except vitamin B1 is inadequate in the milkless diets supplied to the patients. Diets containing milk were better.

6. Study of Mental Symptoms in India.

Nagendranath De, Calcutta.

Study of mental symptoms in India indicate that they vary widely from those found in the Western countries. A study has been made of these symptoms as found in about 2,200 persons, suffering from various psychiatric disorders, who were examined either as in-patients in a hospital, as out-patients in 4 clinics or as private patients in their homes. Some of them were psycho-analysed.

DELUSIONS

Delusion of persecution as found in the West has almost always reference to persecution of self but here the delusional persecution of the relatives of the patient are quite common and of the relatives the following is the order of frequency: Children, brothers, sisters, parents and lastly the husband, wife perhaps never.

Among the methods of persecution not often found in the West are sucking of blood and employment of goondas for physical torture. Transference of disease by some magical means is a common method; another rather uncommon method was what the patients described as "obstructing the flow of life". This may be effected by means of a "ban" (arrow) or by other means. These *bans* were endowed with super-natural power by means of mantras.

The communal and political tension prevalent in the country often gave a colouring to the persecution. The supposed persecutor was often a member of the opposite political or communal party.

In delusions of poisoning, the vehicle for the poison is often a 'pan' (a dressed bettle leaf). Here some poisonous drugs or some potent 'mantras' play their part.

In megalomanic delusions the delusion of chastity is commonly found because chastity is valued by Indian women more than any other possessions. Among material possessions horses and elephants, play an important part probably because of abundance of these things in nursery stories. To understand the megalomanic delusions about religion one must be conversant with the stories and myths of the Indian religions. I think it is possible only in India that a megalomanic religious delusion is expressed in a most humble way *e.g.*, "I am a sweeper, my duty is to clean, to clean the world, God has ordered me so".

Self-depreciating delusion of sin is quite common. The following are regarded as the worst sins by the Hindus: causing an abortion, causing the death of one's own mother, father, a brahmin, a cow or any person, touching a diety with unclean body or clothes and misappropriation of money.

Delusion of influence in this country has almost always a mist of mysticity round it. The influencer is often believed to be endowed with mantras or tantras having supernatural power. Delusion of influence of self and other persons is also often supernatural in its performances.

Somatic delusions are quite common and many of them are associated with delusion of poisoning. Some patients are found to have systematised somatic delusions alone and are diagnosed as somatic paranoia.

OBSESSIONS

Obsessive thoughts, ideas of action are often intimately connected with religious ideas. The idea of passing urine and faces on the heads and faces of dieties. Sexual obsessions towards goddesses are very common obsessions. Obsessions on scientific subjects like life, the universe, electricity, radio, atom bomb etc. are not less but are rather more common than in the west.

Obsessive imagery in which an image, often a sexual one, persists before the mind's eye without any associated thoughts or wishes, are quite common. They are not the remembered images if anything actually seen but are the products of imagination.

Obsessive feelings are found in those cases in which there is no accompanying thoughts or ideas on one hand nor can this feeling of tension and distress be relieved by any compulsive act.

Obsessive tendencies are intermediate in form between obsessions and compulsions. They differ from obsessions in that they are tendencies for action and from compulsions in that they are never carried into action. Some of them are sexual in nature. Stealing tendency is also a very common one.

COMPULSIONS

Over 90 per cent of the compulsions are either washing or performance of some rituals associated with the idea of uncleanliness. The acts are symbolic in most cases. Compulsive speech and writings are either unconscious wish fulfilments as in cases of utterance or writing of obscene words and sentences or expiatory in nature as in cases of reciting or writing the names of gods and goddesses for a definite number of times or saying a prayer for a definite length of time before which no rest can be obtained.

Compulsive repetition of actions for a number of times is quite common. Closely allied to this is the compulsion of having things in duplicate or triplicate or not at all. Compulsion to do and undo things in the same fashion is not rare. If such a patient enters a room by one door and comes out by another he has the compulsion to enter the room again by the 2nd door and come out by the first.

Just as there are cases of compulsive acts there are also cases of compulsive inactivity. The patient describes his symptoms by saying that he feels hurdled on him a big stone of inactivity which he is unable to remove.

DOUBTS AND INDECISIONS

Pathological doubts are of ordinary kind. Indecisions are always accompanied by anxiety. Many of the indecisions found here are dependent on local superstitions *e.g.*, which foot to put forward first when starting for a long journey.

HALLUCINATIONS

Auditory hallucinations are by far the commonest and they are voices in most instances. About half of them are friendly conversations with gods and goddesses and with living or dead persons, known and unknown, and the other half are usually commands, threats or abuses mostly in filthy language. Hallucinatory commands are usually very exacting and often against the conscious wish of the individual. Visual hallucinations are far less common and only in rare instances visual and auditory hallusinations are combined *e.g.*, a person is seen standing in front in a shadowy form, and talking.

Olfactory hallucinations are more common in this country than in the Western countries. This is connected with the belief that when gods and goddesses appear they fill the air with smell of sweet flowers and that some Sadhus can also do so.

PHOBIAS

The ten commonest phobias are mentioned below in the order of frequency in which they are found in this country:—Diseases, death, ghosts, loneliness, insanity, animals, thieves and dacoits, punishment, enclosures (including rooms) and fall (with or without death). Of the diseases tuberculosis is feared most though leprosy is hated most. In some cases of fear of death it is not the fear of one's own death but the death of near relatives that is apprehended.

PHANTASY

Almost all the phantasies are sexual either in the direct or in the indirect form. Many women and some men think themselves to be wives of God in phantasy. Unmarried women become married in phantasy and put on the dress and signs of married women. Married women sometimes phantasy themselves as unmarried.

7. Treatment of Dermal Donovan-leishmaniasis with X-Rays.

G. PANJA, Calcutta.

Successful treatment of oriental sore with X-rays was described by the author (Ind.Med.Gaz. 1946, 80, 251). Since then, treatment of dermal Donovan-Leishmanias's with X-Rays was tried by the author and found highly satisfactory. The Leishmania parasits were found radio-sensitive. About a dozen cases were treated and eight cases have been recorded. Nodular infiltration and hypo-pigmented lesions on the skin as well as nodular lesions on the tongue were exposed to X-rays. Full erythema doses were given on the nodular lesions and fractional doses on the hypopigmented patches. Stibatin (Glaxo) concentrated, 2 to 3 c.c. intramuscularly, were also given daily for about a month. The lesions which were exposed to the X-rays recovered completely. The hypopigmented lesions which are very refactory to treatment with antimonials disappeared completely. The nodular lesions which were not exposed to the X-rays recovered only partially inspite of the treatment with stibatin. Some cases treated with X-rays alone responded very satisfactorily. Along with X-rays, antimony treatment was given to ensure quicker and permanent recovery. For nodular lesions 4 to 5 exposures were necessary and for hypopigmented lesions 4 to 5 were given. The author treated many cases with neostibosan, solu-salvasan and iodide mixture but no complete cure was obtained. Since introduction of the X-ray treatment he is so satisfied with the beneficial result that he would recommend in every case the combined treatment with X-rays and antimony. Neither any X-ray burn nor any disastrous results were obtained with this treatment.

8. Aetiology of Infantile Eczema.

G. PANJA, Calcutta.

The aetiology was studied under the following heads:—Age, sex, age and season of onset, number of the birth of the victim, general health, food, teething, gastro-intestinal disturbances, susceptibility to cold, external influences, such as clothing, soap, oil and exposure, mother's food, family allergy, sites of initial lesions, contagiousness, relapses, course of illness, milk—sensitiveness, eosinophilia, condition of stools, seborrhoea and effect of treatment.

The conclusions are that the disease appears to be an atopic dermatitis but the source and nature of the atopen are not yet definitely established. This much can be said that it is not possibly cow's milk. Although sensitiveness to milk is elicited in a large number of eczematous infants, the same is true with non-eczematous infants also. Environments such as clothing, soap, oil and residence and teething have little to do with the causation. No association is found with the mother's food in breast-fed babies. Gastro-intestinal disturbances are present in a very small percentage of cases. Ill-health is not a predisposing cause. Most babies are healthy and fat. Highest incidence is in the first month of life. Eosinophilia 10 to 15% is present in most cases. 30 to 40% of the infants are susceptible to cold. Family allergy is elicited in about 30% of cases. Lower legs, cheeks and scalp are most often affected. The disease is most common in winter *i.e.,* from December to February. It is possible that the lower legs, the face and the scalp become sensitised on account of variation in temperature and exposure to harsh and chilly weather. The affection is not contagious unless secondary infection with pyogenic organisms has supervened. That the external factor plays an important job in the causation is shown by ready response to X-ray treatment.

9. Erythema Pigmentosom—A New Disease Hitherto Undescribed.

G. PANJA, Calcutta.

Many cases have been seen and recorded. The disease is characterized by a sudden onset of circular or oval patches showing erythema, oedema and dark pigmentation. Sometimes vesication is seen. Repeated attacks take place and most eruptions are ***fixed*** eruptions. The disease appears to be due to a toxin from a septic focus. Aetiology, histology, clinical features, biochemistry etc of blood, investigation to septic foci and treatment are described.

10. Diagnosis and Treatment of Tuberculoid Leprosy.

G. PANJA, Calcutta.

Tuberculoid leprosy is otherwise called 'Lepra Reaction'. This is a fulminating tissue reaction characterised by Angry-looking oedema and infiltration which have a tendency to spread and is caused mainly by leprotoxin in a sensitive or partially immune individual. Associated symptoms such as pain, temperature, tingling, etc. may occur. Histologically, a large number of mononuclear cells and giant cells are found.

The reaction may occur either in neuromacular or lepromatous (cutaneous) type of leprosy. Thus a neuromacular type may look like a lepromatous or nodular type of leprosy if an extensive reaction occurs. Microscopic examination usually shows scanty or no leprosy bacilli. But in the reaction of lepromatous type, bacilli are always found. Sometimes the oedema and infiltration are so slight that it is difficult to diagnose the tuberculoid stage. Histologic examination is not easy and always possible. A simple test for diagnosing the reaction stage is to fix a lesion with two fingers, incise with a scalpel, squeeze out the blood-stained fluid and make films like blood films on a slide. Leishman's staining will show a very large number of mononuclear cells including lymphocytes and monocytes and a small number of polymorphonuclear cells. A non-tuberculoid lesion or normal skin will not show such an excess of mononuclear cells. The best way to count the cells is to count 200 mononuclear cells and at the same time count the polymorphonuclear cells and then make a note. Counting of the latter is then continued if necessary until the figure 100 is reached. Mononuclear cells should also at the same time be counted. Thus a double check to the counts is given. It is needless to mention that if mononuclear cells are in great preponderance 100 only should be counted and it is not necessary to proceed with further counting.

It is the tuberculoid stage that greatly upsets the mind of patients and treatment for ameliorating such a condition is of paramount importance. Antimony, calcium arsenic in small doses non-specific vaccine therapy, such as sterodin, polydin, milk, autobeems, redoxon, adrenalin etc. have their values. The author has tried glucose with antistine intravenously daily or glucose in bigger dosage followed by insulin and achieved rapid and remarkable success. Glucose is considered to be drug of choice in lepra reaction. Further work is in progress.

11. Treatment of Lupus Valgaris with Caustic and X-Rays.

G. Panja, Calcutta.

Lesions of lupus vulgaris of the face, chin, buttocks and thighs and of lupus verrucosa on the feet are cauterised with pure phenol followed immediately by strong nitric acid and are also exposed to half to full erythema doses of X-rays at intervals of 2 to 4 weeks. Cases are cured completely and no untoward effects of X-rays have been noted. Some cases have been treated with the above caustics alone and finally cured. Malt extract of codliver oil is given internally when general health is found poor. There is no necessity to administer super concentrated vitamin D in any case. The combination of phenol with nitric acid results in explosive evolution of a gas that penetrates deeply into the lupoid tissue and brings about cure.

12. Enteric Fever in Bombay—Laboratory Diagnosis.

D. W. Soman & B. G. Modi, Bombay.

The paper deals with the laboratory data in the diagnosis of enteric fever, collected during the last ten years, the chief methods used being blood and clot cultures, Widal tests, white blood cell counts and cultures of stool and urine. Different media were tried for the primary isolation of organisms from blood and clot cultures including the problem of contaminated clot-culture; and Hartley's broth and glycerine-peptone-ox-bile medium were found to be the choice for routine blood and clot-culture methods respectively. The comparative value of whole blood and clotted blood cultures was studied and it was realized that the latter gave more positive and earlier results than the former. The commonest organism isolated was B. typhosum during the last ten years, the next being B. paratyphosum A, the ratio being 9: 1. A few salmonella organisms (food-poisoning group), B. faecalis alkaligenes and B. Coli were also isolated, on rare occasions. Relationship between Widal and Cultural examination was studied in a group of cases and it was strikingly observed that approximately 40% of bacteriologically proved cases showed negative Widal reaction, although blood was collected after 10th day of fever. The diagnostic value of Vi agglutination in the un-inoculated cases, was found to be low as compared with that of the combined method of H & O agglutination.

The white blood cell count as well as the differential count, did not give significant help in the early diagnosis of an enteric case.

Selective media were tried for the isolation of causative organism from stools and urine and D.E.C. medium was found very useful for isolation of these intestinal pathogens.

13. Rickettsial Diseases in India.

D. W. Soman, Bombay.

The author briefly narrates how rickettsial diseases received such scant attention in India prior to world war II from the medical profession in general and research workers in particular. It is really the last war that has given great impetus to the study of this group of fevers and much data has now been accumulated in India to show that these fevers are quite common in the cities and perhaps much commoner in the country-side. The known rickettsial diseases have been divided into five major groups and those present in India are chiefly discussed in brief in reference to their clinical, epidemiological aspects. The place of laboratory in the diagnosis of this group of fevers is stressed, using proteus and the specific rickettsial reagents. The author has studied this aspect in reference to the Bombay city, where he found the murine or flea-typhus to be prevalent all the year round. The rodent reservoir was studied by obtaining sera for complement fixation tests, which showed that 25% of the rodent population on the whole and 50% on a particular species, Rattus norvegicus suffered from past infection. The occurrence of scrub or mite-typhus in a metropolitan city like Bombay aroused great interest since it was established by the author by isolation of strains from cases of typhus fever and also its peculiar seasonal incidence was demonstrated. As regards the position of tick typhus in India, much experimental work is necessary before it is finally established Latest drugs, such as para-amino-benzoic acid, chloromycetin and aureomycin are discussed in the treatment of typhus.

14. Studies on Experimental Diabetes.

Part IV—Role of Intermediary Fat Metabolites in causing ketoasis in animals and the comparative effect of insulin and amellin in relieving the symptoms.

M. C. Nath and (Miss) Kusum S. Laul, (Nagpur.)

1. Animals receiving daily injection of sodium aceto-acetate do not show initial increase of blood ketone bodies to an appreciable extent till 71 days after which a sudden increase is observed.

2. When amellin is injected simultaneously to the animals showing gradual accumulation of ketone bodies, utilization of those bodies sets in, thus showing the important role played by amellin, either in helping utilization of ketone bodies by the extra hepatic tissues or in checking their excessive formation in the liver.

3. Insulin also helps the process but the utilization is not so high as with amellin.

4. The value of the ketone bodies of the liver of animals treated with amellin for 40 days is far less than that of the control animals receiving sodium acetoacetate alone.

5. Effect of insulin is not so pronounced as that of amellin.

15. Role of Cobalt in Experimentally Induced Anaemia in Rabbits.

Bani K. Bhattacharya and S. B. Broacha, Bombay.

It was known for a long time that Cobalt possesses blood regenerating properties. Recently it has been found out that the new anti-anaemia drug Vitamin B12 contains traces of Cobalt. We have used Cobalt Glycinate because it can be easily administered parenterally and is absorbed slowly in the system, while other salts of Cobalt like chloride and nitrate require large doses.

Six healthy rabbits were bled twice a week for two weeks. Before the treatment started their R.B.C. and hæmoglobin was brought down to 2.5 millions and 5 gm. respectively, and the reticulocytes from normal level of 2 to 25%.

Two rabbits were injected with 10 mgm|kg of Cobalt glycinate and O.1 cc|kg of liver extract, other two with only O.1 cc|kg of liver extract and the rest were kept as control. (Liver Extract used was "Cipalon" manufactured by Cipla Laboratories.)

Altogether seven injections were given intramuscularly on alternate days. In the liver extract cobalt group reticulocytes remained above 30% throughout the experiment. In the liver extract group reticulocytes came down to normal level on the tenth day after the treatment started, in spite of the injections being continued. In the control group the reticulocytes slowly came down to normal in about 8 to 10 days.

In all the three groups the increase of R.B.C. and hæmoglobin regeneration was uniform and followed the same pattern.

16. Metaplasia in Cervical Carcinoma of Uterus.

The present paper is a study of an unusual metaplastic transformation of a frank epidermoid carcinom of the cervix as it invaded and spread towards the funds uteri. Explanation for this metaplasia is attempted in this paper from peculiar histological features of the uterus as compared to the other tissues in the body. Other curious feature of the case was the preference shown by the primary growth to invade through the compact wall of the uterine body rather than produce a familiar cauliflower growth in the vaginal cavity.

17. Detoxification of Tyrothricin by Certain Fungi and Gram-Negative Bacteria.

P. N. Nandi, Calcutta.

Tyrothricin, an antibiotic obtained from *B. brevis,* a normal inhabitant of soil inhibits the growth of *Staph. aureus* at a concentration O.1 microgram per millilitre of nutrient broth thus giving an activity of 1; 10,000,000. It was observed that this antibiotic when applied to fresh soil, inhibits the growth of soil micro-organisms in general only temporarily even at a higher dose (2.Omgm|gm of the wet soil). On continued incubation of the treated soil the substance was not traceable and there was a marked predominance of fungi and certain types of bacteria of the dilution plates. They were isolated and grown in Tyrothricin-containing media in which the growth was almost normal after an initial lag phase.

The culture filtrates and mycelium extracts of some strains of fungi detoxified tyrothricin after a few hours of contact. Similar was the case with Gram-negative bacteria. It was, therefore, concluded that although there is a great possibility of Tyrothricin being produced in soil, the chance of its being toxic to other soil organisms living in association, is very little.

18. Studies on Plant Extracts, Part I. Antibiotics from Hiptage Madablota Gaertn.

A. N. Bose and G. C. Mitra, Calcutta.

In continuation of our previous work on antibiotics from higher plants, further studies have been made to purify the extract from *Hiptage madablota* Gaertn. Roots, collected from various sources were extracted with hot alcohol, hot and cold water or a combination of any two, and later subjected to fractionation by lead acetate precipitation and decomposition by H2S. By such treatment, it has been possible to get metrials from the roots, which were active against a number of pathogens *e.g., Staph. aureus, B. Shiga, E. Typhosa; Sh. Sonnei, Vibrio Cholerae* (Inaba and Ogawa in dilution of 1 in 6000. Against B. Shiga, the Extracts were active up to 1|15000. It is however being noted that extracts prepared from the roots of different places and of different season give extracts with different types of antibacterial spectrum. Thus, while some extract show highest bacteriostatic activity against *Staph. aureus,* others show such against *B. Shiga.* It is suggested that probably more than one antibiotic principles are associated with the plant. It is further found that when purified toxic factor may be eliminated to a great extent.

19. Studies on the Chemotherapy of Bacterial Infections.

PART I.

A. N. Bose, Calcutta.

Sulphonamides are being extensively used in the treatment of bacterial infections, but studies on their chemotherapeutic value against *V. Cholerae* have so far been limited. Attempts have been made from this laboratory to study the synergestic effects of sulph drugs with Cholera bacterio phage (Sen and Basu, Ind. Med. Gaz. 1945). Since it is known that Sulphonamides in active anionic form plays an important part in effective bacteriostasis, various p-hydroxy methyl amino benzene sulphonamide derivatives, have been synthesised and are being studied for possible bacteriostatic and bacteriolytic properties. The compounds, reported in this paper are the respective formalin condensation products of sulphathiozole, Sulphacetamide, Sulphanilyl-benzamide, Sulphadiazine, Sulphamerazine and Sulphamethazine: Anti-bacterial tests have been carried against *V. Cholerae* (Inaba and Ogawa) in 1% Difco peptone water (pH 7.8), Glucose broth, papain digest broth, and by the agar strip method. It is being found that amongst the series tested,—Formo—Sulphacetamide (S.A.F.) and Formo-Sulphathiozole exert the best and equivalent bacteriostatic action, but the latter is much weaker in bacteriolytic properties. Formo-Sulpha benzamide (S.B.F.) exerts the same bacteriolytic action as S.A.F. though bacteriostatically it is slightly weaker. The other derivatives stand below S.A.F. in anti-bacterial potency. It is suggested that both S.A.F. and S.B.F. merits further evaluation in the clinical fields.

20. Studies on the Chemotherapy of Bactorial Infections.

PART II.

A. N. Bose, Calcutta.

In this communication the respective formaldehyde condensation products of sulpathiozole (SFT), Sulphacetamide (S.A.F.), and Sulphabenzamide (S.B.F.) have been screened against a number of pathogenic organisms, viz., *Streptococcus haemolyticus* (Richards), *Streptococcus viridans,* Pnenmococcus Type I, *Staphylococcus Aureus, Escherichia Coli, shigella Dysenteriae* (Shiga), *Shigella Sonnei, Eberthelaa typhosa, S. paratyphi* A, *B. Pyocyanus,* and *B. Proteus Vulgaris* (Ox2 and Ox19). Comparisons have been made with sulphalthiozole(ST). Against St. *viridans,* S.A.F. and S.B.F. appear to be the most active bacteriostatic agents. S.T.F. and S.T. are inactive in this respect S.B.F. exerts the highest bacteriostatic action against the pathogens of the genetourinary tract such as B. *Pyocyanus, Proteus Vulgaris, E. Coli* and *Staphylococcus aureus.* S.A.F. also exerts similar action against all these organisms except having a slightly lower activity against *B. Pyocyanus* and *Staph. aureus.* Even at 200 mg per cent, concentration, S.T.F., is inactive against all these organisms, and sulphathiozole is equally so except for some activity against *E. Coli.* though much below that of S.A.F. or S.B.F. All the compounds exert powerful bacteriostasis against *B. Shiga,* (12.5 mg%) and moderately high effectiveness against E. typhosa. It is suggested that the formaldehyde derivatives, particularly S.A.F. and S.B.F. be given more extensive trials in the clinical field.

21. Studies on the Antibacterial Effect and Toxicity of Amellin.

M. C. NATH and (Miss) KUSUM S. LAUL (Nagpur).

1. A preliminary study on the antibacterial effect of amellin shows that it possesses bacteriostatic property.

2. Growth of S. aureus was inhibited considerably at a concentration higher than 1:500, there being complete inhibition at 1:125..

3. Even when administered orally to the mice in a very high dose of 1000 mg. per kg. body wt., amellin was found absolutely nontoxic.

4. Studies on subcutaneous acute toxicity indicated that amellin proved fatal only when the dose exceeded 750 mg. per kg. body wt.

5. The cumulative toxicity tests (subcutaneous) were also made and a daily dose of even 200 mg|kg. was found almost non-toxic when continued for 10 days, only one out of six dying on the 6th day.

22. Streptomyein in Tuberculosis.

DR. C. N. CHANDRACHUD, Poona.

Streptomycin a drug with antibiotic activity is used clinically in many forms of Tuberculosis. The paper deals with its use in Pulmonary Tuberculosis. Before the discovery of Streptomycin Collapse therapy was the chief method of treatment in selected cases of Pulmonary Tubersulosis and gave fairly satisfactory results with reduction of mortality rate. There is growing tendency to use streptomycin in each and every form of tuberculosis irrespective of its stage with the result that the conventional line of treatment is likely to be set back in addition to the two attendant risks of streptomycin therapy: (1) emergence of drug resistant strains of tubercle bacilli and (2) Toxic effects. For the study of the paper cases of Tuberculosis are divided in to seven groups and the effect of streptomycin noticed. Results in Meningeal and Miliary tuberculosis were disappointing. There was no distinct advantage in tuberculos empyema. Its use was attended with immediate symptomatic relief and this was particularly noticed in exudative type of pulmonary tuberculosis. In Pulmonary Tuberculosis with laryngeal and abdominal complications streptomycin gave good results. It was also found to be a useful adjuvant in some cases of pulmonary tuberculosis treated with collapse therapy. On an average 1 g. was given daily and the total quantity given was on an average 40 to 45 gms. It was used intrathecally and parenterally in meningitis. In empyema it was given intrapleurally and intramuscularly. Toxic effects were practically nil. X'ray plates of patients are produced and as far as possible patients will be demonstrated.

FROM THE DEPARTMENT OF TROPICAL MEDICAL, SCHOOL OF TROPICAL MEDICINE, CALCUTTA

23. Single-dose Treatment of Malaria.

R. N. CHAUDHURI, M. N. RAI CHAUDHURI & B. N. DUTTA, Calcutta.

This investigation was undertaken with a view to devise a simple form of treatment for malaria to suit the mass of people in rural areas who are for various reasons unable to take a full thirapeutic course. The object was to find a single non-toxic dose from the newer antimalarial drugs, Paludrine, Chloroquine and Camoquin which will be able to effect a clinical cure, after which the patient can himself continue to take the drug once or twice a week during the malarial season or longer. Comparative therapeutic trials of these three drugs in single doses (0.5 gm. each) were carried out in a series of 75 patients admitted into the hospital. They included 36 *falciparum*, 35 *vivax*, 2 mixed (*falciparum and vivax*) and 2 *malariae* infections. *Results*:—Clinical cure was effected in all the cases. The asexual parasites disappeared from the peripheral blood within 3 days after the treatment was given, in 80% of cases treated with Paludrine and 100% cases with Chloroquine and Camoquine. The corresponding figures as regards fever were 84, 100 and 100 per cent respectively. Comparison between the latter two drugs shows that all Choloroquine cases and 80% Camoquine cases became parasite-free by the end of the 2nd day after treatment was started, the corresponding figures as regards temperature being 84% and 76%. Thus all three drugs seem effective to the extent of bringing about a clinical cure, Chloroquine being quick, Paludrine slow and Camoquine intermediate.

The patients were under observation for 1 to 2½ months. None of them had any treatment after the single dose they had received on admission. During this period, 9 patients in Paludrine series, 5 in Camoquin and 2 in Chloroquine series had recurrences of fever (parasitic or clinical). These results, therefore, indicate that the clearance of asexual parasites and fall of temperature can be effected though at varying rates, by a single dose of 0.5 gm. of any one of these drugs. This may particularly suit rural dispensing practice in endemic areas, among the semi-immune papulation. Relapses and incidentally reinfection may be suppressed by subsequent weekly or bi-weekly doses.

2. CHEMOPROPHYLAXIS OF MALARIA

The experimental work on the control of malaria in a hyperendemic rural area with weekly or biweekly doses of Paludrine, Choroquine and Camoquin was carried out during the malarial season. There was a definite progressive decline in the infection rate in all the groups except the control. The spleen rate was also considerably reduced. As regards fever it was the general impression that those who took the drug regularly had very little malaria while many of the control group were badly suffering from it. No toxic symptom were encountered in any group.

3. PALUDRINE LEVAL IN BLOOD

The hydrolytic method of Spinks and Totey (1946) was employed to determine Paludrine level in blood following different single doses. The maximum concentration was attained usually 4 hours after the dose. It fell rapidly on the second day and generally disappeared on the fourth day. Individual variations were also observed.

4. PALUDRINE EXCERETION IN URINE

The excretion of Paludrine in urine was studied in a series of malaria patients receiving different therapeutic dosages, employing the method of Gage and Rose (1946). There was considerable individual variation and the time of urinary elimination of the drug was found to vary from 3 to 12 days.

24. Two New Drugs of the Treatment of Kala-azar.

P. C. Sen Gupta, Calcutta.

A series of 26 cases of kala-azar, half of which were stibio-resistant cases, was treated with a new aromatic diamidine compound, viz., 2-hydroxy stilbamidine, (Hydroxystilbamidine). The results were very satisfactory; all the cases fulfilled the criteria of immediate clinical cure. First six of the cases have completed the six months observation period and have remained free from kala-azar. It is very probable that these patients have been permanently cured. The observations to determine the permanent cure rate is being continued.

Another series of 16 cases of kala-azar was treated with a new antimony compound, viz., methyl glucamine antimoniate. The cases treated were mostly (12) previously untreated or ordinary cases of kala-azar. The results have been satisfactory.

The clinical details of the therapeutic trials of these two compounds are presented.

25. Search for new Antibiotic-producing Substances from Micro-organisms for Controlling Disease Producing Organisms.

P. N. NANDI, Calcutta.

Since the discovery of Penicillin, a number of potential antibiotic substances were obtained from fungi, actinomycetes, and bacteria for combating human diseases. In most cases the antagonists were reported to be normal inhabitants of soil.

The work reported here deals with the isolation of micro-organisms from peat soil, cultivated soil, and compost and studies on their antagonistic activities. The isolates were grown in liquid media and the culture filtrates assayed against *Staph. aureus, B. coli, V. cholerae* and *B. typhosa*. The strains showing positive antibiotic-activity were kept in subculture for futher study. From the results of assay it appeared that the specificity of the antibiotic-producing organisms was well-marked in several cases.

Of 540 strains of microorganisms, 36 were antibioticproducing, which include fungi, actinomycetes, and bacteria 20, 9, and 7 strains each respectively. The work is continued further and purification of the active fraction will be followed by clinical trials.

26. A Case of M. T. Malaria Resistant to Paludrine.

R. N. CHAUDHURI AND M. N. RAI CHOWDHURI, Calcutta.

The case illustrates a rare instance of natural resistance of a strain of *falciparum* parasite to paludrine. The drug also failed to cure the infection induced by inoculation of a volunteer with trophozoites. But a second volunteer inoculated with the latter's blood responded to it; he, however, had arsenical injections as well.

27. Bronchial Asthma—its Pathology and Drugless Treatment.

P. G. GOLLERPERI, Poona.

This is a detailed scheme of breath-holding and exhaling exercises for the relief of Bronchial Asthma, based on the theory that the respiratory musculature, specially the abdominal diaphragm and the smooth muscle of the bronchioles, could be educated and trained to disregard the allergic stimulation well known in the pathogenesis of this type of asthma. Certain unconscious bad habits of breathing are held to be responsible for asthma, in addition to the allergic factor. The most important of these bad breathing habits is the misuse in normal respiration, of the so-called Accessory Muscles (voluntary) of respiration of the upper part of the trunk and neck. In the male adult at any rate, normal respiration, when at rest could be best described as mainly thoracic, while it is thoraco-abdominal in the female and almost wholly adbominal in the child. Watching a sleeping child's respiratory movements this becomes very evident. Re-education specially for the Asthma subject to practice volitional abodminal breathing until it become a habit even in sleep, will make for a definite modification of the severity of his attacks. Together with this, a controlled scheme of breathing exercises, with emphasis on the breath-holding of a normal inspiration and a deep and uniform exhalation following it could be exploited in largely eliminating the attacks altogether, and a return of normal good health.

28. 17th and 18th Century Medical Books in Indian Libraries.

D. V. S. Reddy, Madras.

A recent search has revealed the existence of some 17th and 18th century Medical Books of European origin in the Medical Libraries in India. Photographs of title pages, chief contents and historical value of these old books are presented. Whereever the books are not available for detailed study lists of such old books are given. (Photographs and lists will be projected on the screen.)

There must be many other equally old books from their remnants of the Imperial library of the Moghuls or from the Royal Libraries of other Indian Potentates in 16,17,17th centuries. The Libraries of the Early European Settlements and Missions, of the Portugese, the Dutch, the Danish. the French and the English may also contain valuable early editions. An appeal is made to all Scholars and owners of book-collections, to publish lists of such old books with all the details and photographs so that a consolidated list of the early printed works on European Medicine, available in India for study, may be prepared and printed, and all these books or copies of these works may be brought together into a Central National Medical Library.

29. The Bibliography of Indo-European Contributions to Tropical Medicine

D. V. S. Reddy, Madras.

Most of the Histories of Medicine, written by American and Europeon Scholars, devote a few lines or a few paragraphs to ancient Hindu Medicine (Ayurveda) but generally omit to mention the great names and contributions from India to Tropical Medicine, in the 18th and 19th centuries. Still more surprising is the scant space allotted in monographs on Tropical Medicine and in books on the history of Tropical Medicine, to the large number of reports, researches, monographs and treatises, from India, by Europeon physicians and Surgeons, and specially, by that small but immortal band of British Medical Men, serving on the establishments of the three Presidencies in India. Results of a search for such books are presented—(Photopraphs and lists be projected).

Our own India and medical men of the present century in India, the teachers of our medical schools and the few investigators, scattered here and there, have not even heard of these mines of knowledge. Post-Graduate students, preparing theses for degrees, or articles to Medical Journals, are blissfully ignorant of these treasuries of clinical observations, post-mortem findings and lines of treatment. In the course of historical survey of a disease or observation of clinical interest or a drug or mode of treatment, Indian writers begin abruptly with 1900 or preface the article with the reported or distorted statements from Hippocrates, Galen, or Sydenham. It would be more in consonance with the new spirit of Free India and Indianising the studies at the University levels, if our Universities and Journals insist on the study and survey of Indian and indigenous literature, on the particular branch of Medicine or on the particular subject, under discussion. Co-operation from public and private libraries in India and abroad, of WHO & UNESCO is needed for the preparation of an exhaustive bibliography which is bound to be useful, not only for India but for all Nations.

30. Sensitisation of Penicillin Resistant Pathogens.

MISS. MARIAM GEORGE and K. M. PANDALA, Kayamkulam.

We have previously shown that the differences in the susceptibility of certain pathogens to penicillin are associated with differences in their metabolic reactions as well as with the presense or absence of certain catalytic systems in them. Since this assumes significance with reference to the recent findings of British workers who noted the apparent transference of sensitivity from one organism to another we have extended our earlier work.

We find that the growing of penicillin sensitive and penicillin resistant organisms together causes the latter to become sensitive to the drug. Growth together for half an hours at 37°c. is in many cases sufficient to induce such sensitising effects, the acquired sensitivity lasting a fairly long time. Reversal of resistance by such simple processes as mere contact suggests that the sensitivity to penicillin depends upon a highly labile constituent of the bacterial cell. Ribonucleic acid isolated from sensitive bacterial cells such as *Staphylococcus Aureous* was able to reverse the drug resistance in the case of normally penicillin resistant organisms such as *Escherichia coli, Salmonella typhi* etc. The protein moiety of the nucleo-portein prepared from the bacterial cells possessed no capacity to induce any sensitivity.

These results suggest the possibility of reversing natural or acquired resistance of pathogens to drugs at will by suitable and appropriate treatments. The mechanism of sensitisation is not clear, but appears to be due to bacterial adaptation to fresh environments developing in the presence of sensitive organisms. These findings confirm our earlier postulate that complex catalytic systems bringing about the metabolic reactions of the various pathogens, are responsible for either sensitivity or resistance to penicillin of these pathogens and that by suitable adaptive changes pathogens could be trained to become sensitive or resistant to a drug as desired. These findings have important significance in future chemotherapy of bacterial infections.

31. Effects of Drugs on Electrocardiogram.

S. M. BANERJI, S. TEJ AND J. SENAPATI, Cuttack.

The following drugs were used and E.C.G. were taken before and after I.V. administration to human beings,

Calcium Effects were: Slowing of rate, P better by ½ mm QT Shortened by 1 mm diastole increased by 1 mm., T better by ½ mm and R2 of greater voltage 2 mm.

Novarsenobillon: Increase of rate in some P decreased by ½ mm R2 decreased by 2 mm No change in QT and ST and P-Q interval.

B. The following drugs were used to perfuse forg's heart and direct electrograms were taken:

Calcium, Potassium, Adrenalin: Show the expected results as is revealed by record of heart tracings.

Thiamin chloride:—Show initial depression followed by stimulation.

32. Clinical Pharmacology of Rauwalfia Serpentina.

NAGENDRANATH DE, Calcutta.

The action of Rauwalfia serpentina, as observed on using the drung in varying doses in over 500 patients, were:

(1) General vasodilatation noticeable on the skin, specially of the face and conjunctiva.

(2) Reduction of blood pressure when it was abnormally high to begin with.

(3) Depression of the central nervous system at the subcortical level.

(4) Beneficial effects on delusions.

Untoward effects observed were:

(1) Conquestion of face and conjuctiva and running of the nose.

(2) Slowing of the heart.

(3) Some difficulty in respiration.

(4) Nausea, vomiting and sometimes diarrhoea.

(5) Rigidity and tremour with changes in features and speech resembling parkinsonism.

(6) There are cases of idosyncrasy in which toxic symptoms appear even with one dose.

33. Total Phospholipoid, Choline-Containing Phospholipoid and non-choline Phospholipoid in the Serum of Normal Human subjects and in Patients with Cirrhosis of Liver.

M. V. Radhakrishna Rao and N. C. Dutta, Bombay.

Total phospholipoid, choline-containing phospholipoid and Cephalin content of the serum of patients with cirrhosis of liver has been studied and compared with those of Normal human subjects. In II normal human sera, the lipid phosphorous was, on an average, 5.87 mg|100cc serum and the total phospholipoid was 146.68 mg per 100cc serum. These values are somewhat below the average normal standards given in literature for normal persons of western countries. It was found serum phospholipoids are predominantly choline-containing type in normal persons. Non-choline phospholipoid (Cephalin) forms only a small fraction of the total phospholipoids present in the serum. These observations are in agreement with those of Entenman and others (1944). In cases of cirrhosis of liver with long-standing ascites, a marked reduction of the total phospholipoids and particularly choline-containing phospholipoids was noticed. Cephalin content of the serum, on the other hand, showed some increase over the normal values. It was found that with treatment and with partial clinical improvement, there was a decided increase in the choline-containing phospholipoids.

34. Industrial Health—a Problem in India and its Solution.

Dr. S. K. Chatterji, Calcutta.

"Production means wealth. If we do not produce we do not have enough wealth. We must go ahead on the path of creation, construction, co-operation and good will to our brothermen. We want a stream of wealth pouring out from our fields. factories and workshops, reaching our country's millions, so that ultimately we might see our dreams fulfilled. Let us go on with the work, hard work. This production is not for enriching individuals but is to enrich the nation, that is all of us together. If India lives we also live. If India paralyses herself, then we are also paralysed. If we progress in the right direction then a time will come when we can say the truth and strength—Jai Hind."

This is really an inspiring message of our Prime Minister the Hon'ble Pandit Jawaharlal Nehru.

We are still in a period of transition and India has just made the beginning. Attention of the industrialists, capitalists and specialists are now concentrated to the creation of new industries for the benefit of the country. Attempts are being made to discover the various fields of work still untouched and to improve those already in existence. That is a pretty heavy task no doubt.

With industry coming into its own in free India, which is also intended to be a self supporting country, the problem of "Industrial Health" becomes of prime importance to build up a healthy industrial country.

This necessitates a deep study and research with thorough investigation into (1) the normal physiological conditions under which the respective industries may work and develop, (2) the toxicological manifestations under abnormal conditions (3) the diseases peculiar to a particular industry with (4) their pathological and biochemical findings (5) their possible control and remedial measures, (6) the proper food and nourishments required for each individual employed therein according to their age and sex-which also entails (7) the analysis of foods and drugs.

The normal physiological conditions under which a particular industry may work and develop depend upon its own merit and upon various factors.

The toxicological manifestations of various industries along with the various types of diseases peculiar to them are noted. Recent researches into the clinical symptoms following exposure to atomic bomb explosions or working in an atomic energy plant or with nuclear research work are also revealed. The health of the employees—either civil or military both among the ground technicians and the flying staff in the air service also deserve attention.

A through medical examination of the workers off and on, along with the biochemical findings of blood, urine, faeces, pathological and bacteriological examination of the tissue fluids, X-Ray of lungs bowels etc are essential. A control of the various hazards in different industries and their remedial measures are also of prime importance.

The treatment includes not only medicines as applicable to them but a change to a better hygienic surroundings with proper nourishments and good food as well. The deterioration of the food stuff and the medicinal preparations by adulterations entails the necessity of having foods and drugs analysed.

A well organised administrative "Industrial Department" in modified form is needed for the purpose. The Indian Union may have separate units in each of the Provinces with proper staff for supervision and improvement of her own industry. The provincial units will be held responsible for the welfare of the workers there of. Smaller units may be placed in each district and division working under control of the provincial head.

An well equiped laboratory with proper staff for the conduction of chemical, biochemical, pathological and bacteriological examination, one X'Ray clinic and one therapy clinic should be provided for each unit.

The Government, the different industrial magnets and the public should be encouraged to co-operate in this vital matter wih men, materials and finance.

35. Field Application of Artificial Insemination in India.

P. Bhattacharya and S. S. Prabhu, Izatnagar.

A preliminary report on the field application of artificial insemination in India was communicated to the 35th Indian Science Congress. In the present report results of 4005 inseminations carried out of 9 different breeds and stationed at the 3 regional artificial insemination centres run by the Government of India are analysed and discussed. The cow bulls gave on an average 3.98 0.18 c.c. of semen per ejaculate with which 7.7 cows were inseminated while the corresponding figures for buffalo-bulls are 2.85 0.20 c.c. and 3.2 respectively. The largest number of artificial services per bull in the year was 720 in the case of cow bulls and 223 in buffalo bulls. The overall fertility in cows is 68.52% or 1.46 services per conception and in buffaloes 68.21% or 1.47 services per conception.

Similar analysis of the data according to the different breeds has also been worked out and discussed.

36. Effect of Muscular Exercise on Semen Production.

S. S. Prabhu and S. Guha, Izatnagar.

The results from a preliminary experiment carried out under a general investigation taken up to study the effect of muscular exercise on the quality and quantity of semen produced have been given. 8 Kamauni hill-bulls kept under uniform condition of management and dietary regime, were divided into two groups; one group was given an hour's exercise just prior to collection while the other group received no exercise. The treatments were interchanged following the "change over" design and in all 4 collections per week for 2 weeks were studied. For each collection: 2 ejaculates were collected and studied separately. The results were analysed using the technique of analysis of variance. With the exception of semen volume which was higher (1.5 as opposed to 1.28 c.c.) for non exercise group no significant difference was observed in other seminal characters studied.

37. Secondary 'Sex-Ratio' of Normal Births in Indian Cattle.

P. Bhattacharya, S. S. Prabhu and S. N. Chatterjee.

A total of 5246 calvings from Sahiwal, 2556 from Sindhi, 2425 from Tharparker, 891 from Gir, 474 from Cross-bred Sahiwal, 1420 from Cross-bread Sindhi and 72 from Cross-bred Gir were considered. The overall "Sex-ratio" works out to be 103.93 males to 100 female births. The breed-wise "sex-ratio" is as follows:—Sahiwal—105.89, Sindhi—105.80, Tharparker—100.41, Gir—103.89, Cross-bread Sahiwal—103.43, Cross-bred Sindhi—99.44 and Cross-bred Gir—111.76.

38. Incidence of Abortion in Indian Cattle.

P. Bhattacharya, S. S. Prabhu and S. N. Chatterjee, Izatnagar.

With a view to study the rate and frequency of abortion due to all causes among Indian cattle, 13,084 calvings from 4115 cows belonging to 4 pure bred and 3 classes of cross bred milch—cattle maintained at 25 different farms in the country, were studied. Calves dropped before 262nd day of pregnancy have been considered as 'abortions. The total number of cows aborting is 508 while the total number of abortions observed is 597. On an average it was noticed that one cow in every 9 cows may abort. The number of cows which have aborted more than once is 67, which is 13.20% of the total number of aborting cows. The highest number of abortions (25.46%) occurred in the second lactation. Majority of the aborting cows (63.81%) were seen to abort in the first three pregnancies; in subsequent gestations there is a gradual fall in the incidence of abortions. Within a given gestation, it has been observed that there is a progressive increase in the incidence of abortion with advancing pregnancy—the largest number of abortions occurring in the 9th month.

The sex of the aborted calves showed a preponderance of males (males 124.68 per 100 females).

Of the different breeds studied, Gir topped the list with 11.90% abortions followed by Cross-bred Gir, Cross-bred Sahiwal, Sahiwal, Sindhi, Tharparker, Cross-bred Sindhi with 11.11%, 9.91%, 4.11% 3.22% and 2.68% abortions respectively.

39. Study of Gestation Periods of Indian Breeds of Cattle.

P. Bhattacharya, S. L. Mukherjee, and S. S. Prabhu, Izatnagar.

The average gestation periods of 4 pure and 3 grade breeds were studied. The gestation periods (in days) are as follows:—

Sahiwal—285.93 (5246); Sindhi—283.88 (2556); Tharparker—287.93 (2425); Gir—284.36 (891); Cross bred Sahiwal—280.65 (474); Cross bred Sindhi—286.37 (1420) and Cross bred Gir—283.58 (72). Overall gestation periods and gestation periods for male and female births varied from breed to breed and from farm to farm; with the exception of Cross-bred Sahiwal male gestations were slightly longer in length than female gestations.

40. Successful Collection of Semen From Buffalo-Bulls by the "Massage" Technique.

S. Gajjan Singh, S. S. Prabhu and P. Bhattacharya, Izatnagar.

The paper records successful attempts made to collect semen from buffalo-bulls by massaging the ampullae of the Vasa deferentia per rectum. The Experiment was conducted on 4 buffalo-bulls, while 4 cow-bulls acted as controls. On an average, the buffalo-bulls required 10 attempts (made on different days) as compared with 3.25 in cow-bulls, before reacting to the technique. A total of 13 collections made from the buffalo-bulls gave on an average, 1.03 c.c. of semen as compared to 2.5 c.c. of cow bulls obtained from 17 collections.

41. Incidence of "Twinning" in Indian Cattle.

P. Bhattachrya, S. S. Prabhu and S. L. Mukherjee, Izatnagar

The incidence of "twining" in Indian cattle was studied in 4 pure breeds and 3 classes of cross-bred milch animals. Out of a total of 34,084 calvings examined, 28 twins birth were observed, one cow giving birth to twins in successive calvings (3rd and 4th). On an average, one cow in every 152 cows produced twins and a pair of twins was dropped once in every 485 calvings. The percentage of twin bearing cows was 0.686 and the percentage of twin calvings was 0.214. Out of the 28 twins born 14 were of like sexes (900, 5♀♀) and 12 of mixed sexes, while in the remaining 2 cases sex was not recorded. The overall mortality rate (within a few weeks of birth) is 125% in 28 twin births (28 x 2 = 56 births). The gestation periods of male and female like twins and the mixed twins are 278.8 ± 12.62, 278,6 ± 6.36 and 287.42 ± 9.56 days respectively. It has been observed that the majority of the twin births occur in the 3rd and 4th parturition.

42. Study of the Symptonms and Postmortem Lesions in Fowls Experimentally Infected with Ranikhetdisease Virus.

S. Guha and S. N. Chatterjee

In connection with an attempt to raise a Ranikhet-disease resistant strain of fowls at the Animal Genetics Section of the Indian Veterinary Research Institute, Izatnagar, a large number of birds consisting of Rhode Island Red, White Leghorn and Deshi breeds, over eight weeks old, were inoculated with virulent Ranikhet Disease Virus (Mukteswar strain). This material was utilised by us for studying in details the symptoms of the disease and the post-mortem lesions in artificially infected fowls. Out of 1679 fowls injected with virus only 3 bords survived making the mortality rate 99.82%. The average survival period was 3.9 days and the peak of mortality was noticed on the

4th day. Post-mortem examination was conducted on 1644 fowls in all. The general symptoms and the post-mortem lesions have been described.

I. FOWL POX

43. Duration of Immunity Following Vaccination.

S. G. Iyer, S. B. V. Rao, S. P. Beri and D. Ramnani, Izatnagar, U. P.

The imporved vaccine against fowl pox was prepared by incorporating pigeon and fowl pox viruses. Biological tests made with the vaccine demonstrated that the vaccinated birds evinced no immunity after six months, suggesting the need for re-vaccinations.

Studies on Incubation

44. II. Influence of egg size on Hatchability.

S. G. Iyer, B. M. Thakral and Narayanan, Izatnagar, U. P.

In experiments made to study the relation of egg size or egg weight to hatchability results and body weight of the chicks hatched at day old, it has been observed that highest hatchability was obtained in the case of eggs weighing about two ounces while the hatchability percentage decreased proportionately as the weight of the eggs increased. It was further observed that as the weight of the eggs increased the average weight of the chicks also increased more or less proportionately.

45. III. Relation of egg Colour to Hatchability.

S. G. Iyer, B. M. Thakral and Narayanan, Izatnagar, U. P.

In the case of Rhode Island Red breed, the colour of the egg shell is brown but experimental observations with respect to hatchability results have revealed interesting features. The brown of the individual eggs varies in shade so as to appear from dark brown to extremely light brown. The hatchability results involving the use of various shades of eggs of brown colour suggested that there was no justification for a poultry breeder to decry the use of light brown hatching eggs, thus reducing their market value. Highest hatchability results were obtained in the case of eggs of medium brown colour. Necessity for further work is stressed as the colour of the egg shell is governed by genetital physiological and environmental factors.

46. IV. Influence of Tremulous air cell on Hatchability.

S. G. Iyer, B. M. Thakral and Narayanan, Izatnagar, U. P.

Experiments have been made to study the influence of tremulous or floating air cell on hatchability of Black Minorca hatching eggs which had travelled 90 miles by train. The results of incubation trial revealed that there was a definite and significant reduction in hatchability in the case of tremulous air-celled eggs as compared to normal eggs. Normal eggs have a hatchability of 73 *per cent* while in the case of tremulous air celled eggs it was 46 *per cent.*

47. I. Loss of Weight of hen eggs during Artificial Incubation.

S. G. Iyer, B. M. Thakral and Narayanan, Izatnagar, U. P.

In view of the great economic importance of hatchability results to the poultry industry in the production of more protective foods, experiments have been made to study the loss of weight of eggs during the incubation period so that adequate amount of moisture can be provided in the incubator chamber. Eggs from hens of White

Leghorn and Rhode Island Red breeds have been included in the study. The results indicate breed differences and individual variations. The results also revealed that the individual variations were mainly due to the porosity of the egg shell. Infertile eggs apparently lost more weight than fertile eggs during every week of incubation. The optimal loss of weight of a fertile egg during the period of 18 days of incubation should not be more than 7.5 gm.

48. Dried cow Manure in the ration of Growing Chickens.

D. Patrhasarathy, S. G. Iyer, Izatnagar, U. P.

It has been shown by some workers abroad that when growing chickens were fed on a ration containing cow manure at about 10 *per cent.* level, the growth rate was very much accelerated. This was ascribed to the presence of some growth promoting factors in the cow manure. Parallel to the increased growth there was marked comb development also, both in male and female chickens indicating the presence of some male hormones. In an attempt to see if the undesirable hormone influence, could be destroyed by drying at 80°C. for 24 hours without destroying the growth promoting activity, the present experiment was undertaken as this would reduce the cost of feeding considerably in as much as the costly animal protein could be dispensed with. In an experiment of 8 weeks duration starting with day old chicks it was observed that in spite of drying the cow dung at 80°C. for 24 hours, the androgenic activity was not completely destroyed. Further satisfactory growth was not also obtained probably due to the destruction of the growth promoting factors.

49. Part I. Cow manure as an Ingredient of Poultry feed.

S. Bose, S. G. Iyer and H. P. Tandon, Izatnagar, U. P.

Studies have been made on the comparative efficiencies of four experimental poultry rations on comparable groups of Rhode Island Red laying birds. Group I which was fed on basal ration supplemented with meat offals showed improvement in egg production and the high egg production was maintained throughout the experimental period. Group II which fed on diet containing heat treated cowdung in the groundnut cake supplemented ration, impaired the egg production by 9 per cent of Group III which was fed on groundnut cake supplement only. The heat treatment of cowdung at 80°C. for 24 hours, therefore, failed to destroy the androgenic potency. The protein content of each of the above three rations was kept constant at 15.6 per cent. Group IV contained a lower level of groundnut cake supplement and the protein content of the ration was 13.1 per cent. The average percentages of egg production of the birds in the above four groups during eleven weeks' experimental period were 55, 34, 43 and 44 respectively. The result indicated that maintenance and moderate egg production can be supplied by rations containing less protein than the present accepted standard of 15 per cent.

The hatchability of fertile eggs in all the four experimental groups was fairly good and the feeding of cowdung did not have any significant favourable influence on hatchability. It appears that cowdung failed to show the beneficial effect on hatchability in the groundnut cake supplemented ration, because the birds used in the experiment were the progeny of hens fed on the normal balanced ration and the progeny, therefore, had not only the growth promoting factor already present in them, being transmitted from the dams through the eggs, but they were also fed on balanced ration for nine months before the commencement of the experiment.

50. Efficiency of Cocoanut oil in the Preservation of Shell Eggs.

D. B. Mukerjee, Izatnagar, U. P.

Thermostabilised eggs when oiled retained their internal quality better than the ordinary thermostabilised eggs, on storage at room temperature (86.9°F.) for 3 weeks.

Oiling was also found beneficial in preventing undue loss of weight by storage due to evaporation of moisture.

The palatability score of the oiled eggs was higher and the flavour score slightly lower when compared to simple thermostabilised eggs. Egg spilage due to bacterial contamination did not occur at all in any of the treated eggs.

51. Effect of Vaccination on egg Production.

S. G. IYER, G. D. TANDON, Izatnagar, U. P.

Vaccination of chickens against Ranikhet disease when carried out at the age of 16 weeks did not adversely affect any of the economic characters such as the rate of growth, egg production, food utilisation for growth and egg production, fertility and hatchability. Hence, there is absolutely no justification for decrying vaccination in the case of Ranikhet disease.

52. The first outbreak of *Salmonella* infection of poultry in India.

S. G. IYER, S. B. V. RAO and S. NARAYANAN, Izatnagar, U. P.

A serious outbreak of a disease due to *Salmonella* in a large commercial poultry farm in Northern India, giving rise to a mortality of about 50 per cent of baby chicks is described for the first time.

Penetration of the organism into the shell and infection of the embryo and subsequent recovery of the organism under experimental conditions is described, demonstrating the possibility of incubator infection through contaminated egg shells. The isolation of the organism from the livers of ailing chicks, and from the ovaries of the 'Carriers' is recorded. Control measures have been detailed and the disease has so far been kept within bounds.

The field organism is readily agglutinated by the stock serum of *S.* pullorum though accurate serological typing after Kaufman-White still remains to be done.

Further spread of the condition has been checked by periodical blood testing for the removal and destruction of carriers combined with hygienic and sanitary measures.

53. The determination of the percentage of edible flesh in the Rode Island Red, White Leghorn and Desi (indigenous) cockerels at different stages of growth.

T. D. MAHADEVAN and S. BOSE, Izatnagar, U. P.

The determination of the percentage of edible flesh in the Rhode Island Red, White Leghorn and Desi cockerels at 8,12,16,20 and 24 weeks of age respectively, revealed that the percentage of total edible was highest in the *Desi* and lowest in the White Leghorn cockerels at all the stages of growth. The percentage of breast meat was, also, higher in the *Desi* than in the Rhode Island Red or White Leghorn cockerels. As regards efficiency, the three breeds ranged themselves in the following descending order: *Desi*, Rhode Island Red and White Leghorn. The conformation of the dressed *Desi*, Rhode Island Red and White Leghorn cockerels were classed as fully fleshed, fairly well fleshed and poorly fleshed grades respectively.

54. Studies in Equine Blood Groups.

C. S. BALAKRISHNAN and DR. S. N. YERAVDEKAR, Bombay.

1. Results of grouping of the blood of 611 horses mostly Indian Thoroughbreds are outlined and discussed.

2. 4 Groups, A, B, AB and O analogous to those in Human Blood are recognised to exist in horses also.

3. The distribution of these groups is peculiar and varies widely in Thoroughbred Indian Horses and Australian Horses. It is found to be as shown below:—

Indian Thoroughbred	10.2	5.7	0.4	83.7	%
Australian	8.5	24.5	8.5	58.5	%
ANIMAL:	A	B	O	AB	

4. The reciprocal relation between agglutinogens and agglutinins is maintained. But incomplete bloods such as Group B and Group O without agglutinin 'a' have been found.

5. The use of a very strong preservative namely .1% Brilliant Green and its advantage in eliminating the need for strict aseptic measures in serum preparation is pointed out.

6. A special technique of cross-matching involving serum dilution and accurate cell suspension is explained.

7. The problem of icterus neo-natorum in horses and the value of blood grouping, in advancing research on the problem are indicated.

8. The case of a Group O mare mated to two Group AB stallions producing 2 Group AB foals to one, and one group O, one Group A-B, and one Group A foals to the other is reported.

9. A statistical study of the genetic aspect of the distribution of blood groups in Thoroughbred Indian Horses is made and the data are shown to be incompatible with Bernstein's theory of Human Blood Groups.

55. A Preliminary Investigation in "Bovine Lymphangitis".

D. Krishnamurty, Madras.

Although this disease was recorded in India as early as in 1908 and occurs mostly in a sporadic form in provinces situated along the east coast of the country, particularly in Madras, it has not yet passed the preliminary stages of investigation. This paper records a series of experiments conducted on some fundamental aspects of the disease pertaining to its etiology. In order to establish the relationship between the causative organisms and the disease, experiments have been conducted to prove the different stages of Koch's postulates. Subcutaneous route has been first chosen for transmission of the disease to healthy bullocks and only a local reaction—ensued after such inoculation which is in conformity with the previous findings. Different portals of infection have been tried later to produce a progressive disease similar to the natural one.

A progressive disease involving several superficial lymph glands and showing even the laminitic phase has been reproduced by one of these methods. This route has been utilised to prove different stages of Koch's postulates. A preliminary study of these organisms has indicated a close resemblance to those described by V. K. Iyer. Experiments have also been conducted on recovered animals and artificial inoculation produced the same intensity of reaction in them as in the healthy stock. In addition to the above experiments, the results of the investigation conducted on some other aspects of this disease, 'Bovine lymphangitis' have also been included in this paper.

56. A Case of Generalised Tuberculosis in Monkey, (Mecaca Sp.).

K. P. Chandrasekharan and D. Krishnamurty, Madras.

This paper records a case of open generalised Tuberculosis in a Monkey (Mecaca Sp) which was captured from the forests in Burma. The animal showed cutaneous ulcerations and several tuberculous nodules in the musculature of the right fore-limb, besides lesions in most of the internal organs. Histo-pathological examination of the lesions showed a fulminating type of tuberculosis with entire absence of giant cells or calcification. Biological test revealed that the infection was one due to Mycobacterium tuberculosis var hominis. It was considered that the route of infection in this case was the external ulcerating wound.

57. Preophylactic Canine Vaccine Against Rabies.

J. R. Dogra, Bombay.

Attention is drawn to the importance of periodic prophylactic vaccination against rabies as an essential measure in the prevention of canine rabies in India.

A carbolished 25% sheep brain vaccine is described. It is a single dose vaccine, administered subeutaneously. Using Habel's technique for assaying the potency of anti-rabic vaccines results are given of seven different brews of the vaccine. Keeping qualities of the vaccine have been ascertained.

Preliminary experiments on dogs are recorded and lines of further work in hand are indicated to stimulate further research in this field by other workers.

58. Clinical and Haematological Studies on Aplastic Anaemia in the Tropics.

C. R. Das Gupta and J. B. Chatterjee, Calcutta.

The term aplastic anaemia is usually defined as a severe and fatal anaemia caused by hypoplasia or aplasia of the bone marrow and characterised by anaemia, leucopenia and thrombocytopenia. The term is also applied to the cases of refractory anaemia even if there be no associated leucopenia and thrombocytopenia. The results of investigations on seven cases, six of which belonged to the former category are reported here. Excepting in one patient who was a radiologist no casual relationship would be established with the occupation. Antecedent history of malaria was obtainable in 5 patients. Enlargement of spleen and|or liver was seen in 4 cases. 5 patients were running temperature of varying degree. Total duration of illness varied from 2 months to 2 years.

Hæmoglobin values varied from 2.47 gms. to 9.5 gms. while red cell count varied from 530,00 to 2,100,000. Blood picture was macrocytic in 2 cases. dimorphic in 4 cases and normocytic in 1 case. Anæmia was associated with leucopenia and thrombocytopenia in 3 cases and with thrombocytopenia alone in 1 case. Hyperbilirubinæmia was present in 1 case who showed jaundice clinically. Myelogram showed varying degrees of hypocellularity in all the cases with absolute decrease of cells of all the types though relative increase of lymphocyte was noted in 6 cases and of late normoblasts in 2 cases. No megaloblasts was seen in any of the cases. Fractional gastric analysis was done in 5 cases, 2 showed hypochlorhydria and 3 isochlorhydria. All the cases excepting one, in which only the erythropoietic tissue was involved, ended fatally inspite of repeated blood transfusions, haematinics and supported treatment.

Comment.—Use of the term aplastic anæmia in a very wide sense for the cases of refractory anæmia is misleading. It is suggested that the term myeloplasia should be applied to such cases, restricting the use of the term aplastic anæmia to those cases in which there is involvement of erythropoietic tissue alone.

59. Sturies on oviducal alkaline Phosphatase in normal and in sex hormone treated pigeons.

Amiya B. Kar, Calcutta.

The distribution of alkaline phosphatase has been studied cytochemically in the oviduct of normal and in the oviduct of sex hormone treated pigeons. In the oviduct of normal juvenile pigeons there is very little or no phosphatase activity. The enzyme activity is spectacularly increased in the oviduct of birds treated with estradiol dipropionate (25000 dipropionate units daily for 10 days). Testosterone propionate (2.5 mgm. daily for 10 days) is less effective in augmenting the oviduct phosphatase activty. The possible physiological role of alkaline phosphatase in the avian oviduct and its relationship to sex hormones is discussed.

60. Creepin Myiasis in Man An Unusual Case.

S. M. Ghose, Calcutta.

A rare case of human myiasis due to warble fly larva is reported. A short description of myiasis producing Diptera is given. The larva recovered has been identified as the larva of Hypoderma bovis in its second stage of life cycle. Contact with inefected cattle or resting on infested ground is probably the mode of infection. No special treatment was necessary.

61. Isolation of Active Polysaccharide Fraction from the Haffkine Plague Vactine.*

S. C. Seal, Calcutta.

A polysaccharide yielding osazone resembling Arabinose osazone and having a melting point of 166°-168° C has been isolated from the Haffkine vaccine supernatant as well as from the specific soluble protein and to a less extent from the bacterial debris of only the protective plague strains including both virulent and avirulent organisms. It is absent in the pseudotuberculosis as well as in the non-protective avirulent plague organisms.

It is therefore suggested that the specific protective substance of the plague bacillus is a polysaccharide-protein complex.

*This work was carried in 1942-43 at the Haffkine Institute, Bombay.

62. Casein Hydrolysate Agar—A New Solid Medium for the Growth of *Pasteurella pestis* and allied organisms.†

S. C. Seal, Calcutta.

The casein hydrolysate agar medium prepared by adding 2.5 per cent agar to the standardised casein hydrolysate broth containing 0.01 per cent liver extract forms a convenient and good solid medium for the growth of *P.pestis* and allied organisms.

After the agar is melted by steaming and distributed in the containers a temperature of 11°C and a pressure not exceeding 10 for 20 minutes in the autoclave have been found suitable for final sterilisation.

The obvious advantages of the medium have been indicated. There is scope to improve it for more gereralised use.

†This work was carried out in 1941-43 at the Haffkine Institute, Bombay.

63. The incidence and control of the TYPHUS group of diseases in the Armed Forces of India.

Major. C. G. J. Speechly IAMC, Poona.

(1) *Nomenclature*:—

Since the knowledge of the biological properties of rickettsiae is still incomplete, no satisfactory nomenclature can be definitely laid down but a tentative classification on

Megaw's Vector basis has been adopted by the Army in India for convenience and early notification of the disease.

(2) *Epidemiology*:—

The analysis and distribution of the various types of typhus in India have been collected from date obtained in AFA 35 (Infectious Diseases Report) Med. Directorate New Delhi compiled for all typhus cases occuring in the Army, in India.

(3) *Laboratory Investigations*:—

Here an analysis is given of the three Serological Tests used in the diagnosis of Typhus Fever viz: the Weil Felix test. Rickettsial Agglutination test and the Complement Fxation test. This is to demonstrate the efficiency of the Comp. Fixation test as compared with the others.

(4) *Preventation Measures*:—

Here such preventative measures as Vector control, Animal host control and the value of prophylactic Typhus vaccine is briefly touched on. Considerable work in this direction has been carried out recently on a large scale by the Field Typhus Team in Kashmir.

64. *Title*:—Some observations on the average normal prothrombin time.

MAJOR. B. D. P. RAO IAMC, Poona.

Experiments to determine the levels of average normal prothrombin time and the various factors affecting it, in the Indian soldiers, have been carried out in this Department. Some of the factors that have been investigated are (1) the effect of a previous meal, (2) the anticoagulant to be used to collect blood (3) time interval between the last meal and collection of blood (4) the concentration of the thromboplastic factor to be used and (5) the order in which the reagents should be mixed.

The conclusions arrived at are described and their practical significance discussed. Chylous plasma, in addition to being opaque and thus causing difficulty in noting the end-point, gives low results. Optimal dilution of the thromboplastic material seems to be a 1|20,000 dilution. Oxalate is a better anticoagulant than citrate, as with it the findings are more consistent.

65. Foreign Body Granuloma in the veins of a Puerperal Uterus Case report.

LEO KRAINER LT. COL., Poona.

A fair number of uterine veins was found obstructed by granulomatous tissue. Squamous epithelial cells and delicate (Lanugo) hairs were found enclosed in the granuloma. It is thought that these inclusions causing the granuloma are material contained in the amniotic fluid.

The findings indicate that amniotic fluid and its admixtures may enter the maternal circulation.

66. Paper on Anemia.

LT. COL. P. N. BARDHAN, Poona.

The classification and etiology of anemia are briefly reviewed. Case notes are detailed illustrating use of Folic Acid in different types of anemia.

Successful results were obtained with megaloblastic re-actions of bone-marrow. Slides of blood and bone-marrow smears will be shown.

67. Use of Stilbamidine (M & B 744) in the diagnosis of latent Trypanosomiasis in bovines.

H. N. Ray, Mukteswar-Kumaun.

The usefulness of a 10 per cent solution of Stilbamidine (M & B 744) in sterile distilled water in detecting latent cases of bovine surra caused by *Trypanosoma evansi* is described. The procedure is as follows: take 0.5 c.c. of the above solution in an agglutination tube; add one drop of suspected serum by means of a pipette. If on immediate coagulation the immediate coagulation the drop remains at the bottom of the tube and takes 5 to 10 minutes or more to dissolve the reaction is taken as positive (+ + +), but if on immediate coagulation the coagulum floats up, forms a ring at the surface and dissolves within two minutes the reaction is taken as negative (0). A positive diagnosis is also made in case the coagulum on floating begins to sink down almost immediately either in big lumps (+ +) or in small shreds (+) and finally the whole thing settles down at the bottom of the tube to dissolve within 5 to 10 minutes.

The blood sera of bovines infected with other blood protozoa such as *Babesia bigemina* and *Theileria annulata* or both and that of bovines reacting to rinderpest virus behaved negatively.

The sera of horses and mules infected with *T. evansi* also gave negative reaction while experimentations with buffalo serum gave inconclusive results.

This test promises to be of immense value in controlling surra in this country by detecting the latent bovine carriers and their subsequent treatment with the specific drug before the fly season is on.

68. The efficacy of phenothiazine in mixed natural infection of gastro-intestinal nematodes in goats.

P. K. Sinha, Izatnagar.

Phenothiazine was tried as an anthelmintic against a mixed natural infection of mainly *Oesophagostomum, Haemonchus, Bunostomum* and *Trichuris*. The intensity of infection in the lot varied from light heavy. Three different dose rates of 0.25 gm., 0.5 g.m., and 10. gm. per pound body weight were applied to three batches of 3, 5, and 2 goats respectively. Egg and worm counts were the criterion to judge the effect of the treatment. Dosing was very quick and without slightest wastage by the use of a funnel and rubber tubing as a stomach tube. *Oesophagostomum* and *Haemonchus* were passed in large numbers. *Haemonchus* were more quickly affected than *Oesophagostomum*. Most of the *Oesaphagagostomum* were passed in the 2nd and 3rd day. On *Trichuris* the effect was very little. On *Bunostomum* the action was uncertain. The effect of 0.5 gm. and 0.1 gm. dose rates were only a little more effective than 0.25 gm. dose rate; and that was far from proportional. 0.1 gm. dose rate was not harmful. So 0.25 gm. dose rate appeared to be optimal in view of its efficacy, economy, less bulk and safety. There was greater inhibition of egg production in the surviving worms by the two higher dose rates. The excretion of phenothiazine in urine, faeces and milk continued for varying period from 5 to 10 days as indicated by the change of colour of the said materials. This period was independent of the dose of the animals.

69. Effects of Light Infection of the Fowl-tape-worm *Raillietine cesticillus* (Molin) on young chickens.

S. C. Dutt, Izatnagar.

Experiments involving parasitized and control chicks were carried out to determine the effects of light infections of *Raillietina cesticillus* on week old chicks fed on adequate diet. Cysticercoids used for infecting the chickens were grown in beetles (Coleoptera).

Effects on growth rate, mortality, feathering and on the infected part of the intestine were studied.

Effect of 5 to 36 worms with a mean of 21.6 per chick on growth-rate was found to be non-significant. 16 one week old Hhode Island Red chicks were used. Of these 8 were given an infection of 95 cysticercoids each and the rest served as control. During a period of 8 weeks the mean gain in weight of the parasitized group was 300 grams, while that of the control group was 311 grams.

Death rate of the parasitized group was found to have increased due to the intestinal obstruction by the worms.

Studies on the effects on feathering and on the infected part of the intestine were based on 18 parasitized and 10 control chicks. Retarded and poor feathering and desquamation of the jejunal epithelium were the main deleterious effects observed.

70. Legal Medicine—its study and Practice in India.

DR. S. K. CHATTERJI, Calcutta.

Of the various branches of the science of medicine—the subject of legal medicine is of no less imporance and at the same time most neglected. This subject is looked upon as one of the minor subjects in the course of study of medicine in the Indian Universities. Being engaged in the medicolegal work and criminological investigations for over 20 years I do look upon the subject not only as one of most interesting but also as one of the most important ones for the service to the State and the people.

Medical jurisprudence and forensic or legal medicine had all along been looked upon as one and the same subject—but strictly speaking they are not.

Medical jurisprudence is the branch of the law dealing with the organisation and regulation of the medical profession whereas forensic or legal medicine is the branch of medicine dealing with the application of medical knowledge to the purposes of the law.

The heavy responsibility on the part of the medical practitioners appearing in the court as medical jurists entails a thorough study of the subject of legal medicine as it is on his evidence only that the life or liberty of an individual would depend.

From the history of origin and development of the science in India, it is noted that the study and practice of Legal Medicine in India dates from the very antiquity, though of course it did not come to a stage of perfection till the 16th Century A.D. when due to the advent of many scientific researches conducted by eminent chemists and toxicologists in the West, that much advancement was made in this country as well. It was in the 19th Century that further advances were made in this direction by the discovery of the main alkaloids like strychnine, brucine, morphine, codein, conine, nicotine, atropine, hyoscyanine and aconitine etc—their isolation from crude plants and testing their chemical and physiological properties. The invention of "microchemical tests" towards the latter part of the 19th Century along with the "colorimetric" and the "spectroscopic" methods of analysis were of great help for the toxicological work to the detection of small amount of organic poisons in the human and animal tissues in cases of poisoning. The application of "electro-chemistry", "ultra-violet rays", infrared rays" or "X-Rays" in the criminological and medicolegal work are all of recent dates.

Much has been advanced in the direction of the analysis of the blood and seminal stained articles. The determination of their origin and their group tests by serological examination—are all coming to a state of more and more accuracy.

In the semen stained articles the finding of spermatozoa under the microscope either in an entire form with the head and tail or the head alone is considered as the criterion though of course some are of opinion that the finding of the heads alone should not be bases upon but there must be found the entire spermatozoa in the specimen to give a definite opinion which I should think is a baseless ground.

With the advancement of the studies and researches in the domain of physics and chemistry a rapid development of the medicolegal science is still in proguess. Newer methods and techniques are being invented in quick succession with a sustained tendency towards greater precision and reliability so that the complex medicolegal problems may be handled, in the near future, with greater case and simplicity, with less amount of labour and time, with more accuracy and at the same time with minimum cost.

In view of the importancy of the nature of work and as it is imperative on us to develop the sciences in this free India of ours—I do feel the urgency of having one "Medicolegal Institute" for each Province, with attached post mortem centre, a general laboratory, a pathological and bacteriological laboratory, a chemical laboratory and a Research section along with it—so that the whole of the medicolegal work of the Province may be conducted in the single laboratory, as is the practice in some of the Western countries.

Thus it will act not only as the controlling and guiding centre for the medicolegal work of the Province but I do believe that such work will be conducted in a smooth and efficient manner, with quick disposal of the cases and at a minimum cost. The authorities of the Central and Provincial Governments may be moved to work it out in that direction with benefit to the State and the People.

Special stress should also be made to the study of the subject of legal medicine in the Indian Universities both in the graduation course as well as in a post graduate course of training specially convened for the purpose for the benefit of the officers who would select the subject as their special profession.

71. Studies on the Specific Soluble Protein of Pasteurella Pestis and Allied Organisms.

Professor Epidemiology, Calcutta.

Certain chemical, physical and serological properties of the protein fractions of the plague and allied organisms precipitated from their vaccine filtrates at 1|3rd, (½-1|3) and ½ saturation of sodum sulphate have been described.

Generally, two fractions, P.1|3 and P½-1|3, were isolated from all strains grown in casein hydrolysate medium but no distilled water autolysate protein was isolated from the avirulent non-protective plague or pseudotuberculosis organisms and only a small amount was obtained from 53|Hav strain.

Most of the protein fractions isolated from the casein hydrolysate medium when dried into scales looked light brown to deep brown, the colour having probably been mostly derived from the medium. The autolysate was, however of light greyish white colour.

The solubility of these proteins was found low, usually not higher than 1 : 500. The highest solubility, 1 :200, was shown by L|auto P½ fraction. The acetic acid precipitate was relatively more soluble than the sodium sulphate precipitates. They remained as complex substance even after fractionating. The solubility could not therefore be used as a guidance for the purity of the substance.Other physical, physico-chemical electrophoretic or spectrographic examinations were necessary.

The nitrogen content varied in different fractions between 9.8 and 15.8 per cent, the highest being shown by L|auto P.1|3. On the whole, there was a progressive deterioration of the nitrogen content from the protective antigenic strain to one of extreme dissociant form of plague strain having non-protective anttigenerity. The nitrogen contents of the protein fractions from the pseudotuberculosis strains were near about 12 per cent, the P.1|3 and P½ fractions not differing from each other as in case of L|auto P.1|3 and P½-1|3 fractions.

All protein tested were Molisch, biuret, sulphur and phosphorous positive. The autolysate proteins did not give positive reactions for tryptophane or tyrosine but the protein fractions of virulent and relatively avirulent protective plague strains grown in casein hydroloysate medium contained both these amino-acids, whereas those obtained from non-protective plauge and pseudo-tuberculosis organisms contained little or none. Since tryptophane was not supplied in the casein hydrolysate medium in which it was lost during the prolonged acid digestion, it is likely that the plague organism could synthesize this amino-acid during growth.

No result was obtained when the protein solutions were tested for specific rotation.

The absorption spectra in the ultraviolet region of the quartz ultraviolet spectrograph (Carl Zeiss) yielded very interesting results. The two fractions Lauto P.1|3 and L5 P.1|3 isolated from the virulent plague strains 228 μ and 353 μ wavelengths. This bend, obtained repeatedly in the above cases, was absent in the curves given by the avirulent (protective and non-protective) plague and pseudotuberculosis strains, which were generally shifted towards the right. So far, this was the only distinguishing feature noted between the virulent and avirulent protective plague strains.

Two distinct fractions were isolated, P.1|3 and P½-1|3 mentioned as antigens A and B respectively. Serologically the P.1|3 fraction (antigen A) of the virulent and avirulent protective plague strains differed from their (P½-1|3) fraction (antigen B) and from P.1|3 and P½-1|3 fractions of the non-protective avirulent and pseudotuberculosis strains except a light cross reaction being noted between 120|5Hav P. 1|3 and L5 P. 1|3 fractions probably indicating the existence in the former of a residual antigen equivalent to L5 P.1|3. The (P½-1|3) fraction of virulent and avirulent protective plague strains cross-reacted with the P.1|3 or P(½-1|3) fractions of the non-protective plague or pseudotuberculosis strains. Thus the plague strains seem to have been related to the pseudotuberculosis strains through this fraction. The latter having reacted also with the anti-serum against boiled virulent plague strain necessarily come from the somatic part of the organism. There was no difference between P.1|3 and P½-1|3 fractions of the autolysate protein and of the non-protective avirulent plague and pseudotuberculosis strains.

The most specific antigen of the virulent plague bacillus was Lauto P.1|3 fraction. The specificity of the other P.1|3 fractions isolated from the same virulent plague strain grown in casein hydrolysate broth seemed to depend upon the quality of the medium as shown by the week specificity and broad|antigenic relationship of the L3 P.1|3 fraction isolated from the basal casein hydrolysate medium.

III. Certain chemical, physical and serological properties.

72. Biochemical Changes in blood in "Phrynoderma".

K. Rajagopal and S. R. Choudhury, Calcutta.

Hyperkeratosis follicularis has been recognised without question as a manifestion of Vitamin A deficiency. Lucius Nicholls over a decade ago gave the name "Phrynoderma" to this condition and the sign has been popularised as an index of Vitamin A deficiency in routine Nutritional surveys. Aykroyd and Rajagopal (Ind. Jour. Med. Res. 1936, Vol. 24,p. 419) however, cast some doubts on this, as a result of their nutritional surveys carried out in Malabar where they found no correlation between other signs of Vitamin A deficiency and Phrynoderma. It was suggested by them for the first time that fat deficiency might be responsible for this syndrome.

Twenty two cases of Phrynoderma and eight controls were studied (in collaboration with Dr. L. M. Ghosh of the Skin Department of the School of Tropical Medicine for the clinical part of the work) regarding the lipid constituents in blood. Serum analysis for total lipids, total chlesterol, fatty acids and iodine value of fatty acids were carried out. Individuals showing phrynoderma were dosed with linseed oil by month (3 tea spoonfuls twice a day; total of 3|4 ozs. a day) daily. Improvements as visible by the unaided eye was noticeable in two weeks and cure resulted in four weeks to twelve weeks. The iodine value of fatty acids which were strikingly lower than in controls returned to normal after treatment with linseed oil. It can therefore be surmised tentatively that 'phrynoderma' is perhaps due to insufficient amount of unsaturated fatty acids available to the body. The figures below give the averages of the lipid analysis of blood.

In mg. per 100 c.c. serum

	Control	Before treatment	Phrynodenma after treatment
Total lipids	442	427	487
Total cholesterol	134	145	140
Total fatty acids	308	279	356
Iodine number of fatty acids ..	112	92	112

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SECTION OF ANTHROPOLOGY & ARCHAEOLOGY

President : Dr. C. Von Fürer-Haimendorf, Ph.D.

PREHISTORIC AND PROTOHISTORIC BELLARY

B. Subba Rao, Poona.

This paper incorporates the results of an intensive study of the Bellary region, which is considered to be "the pivot of the Lower Deccan" and a corridor for the migration of cultures, on account of its being an area of maximum inter-communication in South India. The systematic exploration in the district and the excavations conducted by the writer at Sangankalu and by Dr. R. E. M. Wheeler at Brahmagiri have enabled us to correlate the Prehistoric and Early Historic cultures in the heart of the Deccan peninsula.

The following is the main sequence of cultures in the region :—

(1) Palaeolithic with two distinct industries, whose relation remains to be established ; Abbevillo-Acheulean hand-axe industry and a Pebble industry resembling the Sohan.

(2) A Proto-Neolithic industry represented by crude microliths of quartz and heavily patinated flakes of trap and sandstone.

(3) An early neolithic represented by patinated chipped and ground celts, and the other tools.

(4) Late Neolithic represented by fresh chipped and ground tools.

(5) "Early Chalcolithic stone age" characterised by the occurrence of copper.

(6) Megalithic cultures over-lapping into the Satavahana period. (Illustrated)

BLOOD-GROUPS IN INDIA

(Bihar, Maharashtra and Kerala)

I. Karve and V. M. Dandekar, Poona.

About 2,000 people were examined in each of the areas named. In all, 6,000 people were examined. The sample of 2,000 for each region is distributed among various castes and tribes. The differences in the gene frequencies within a region and those found between the regions are discussed. The paper deals with the A, B, O, system of blood-groups only.

THE LITHIC TOOL INDUSTRIES OF THE SINGRAULI BASIN

V. D. Krishnaswami and K. V. Soundararajan, Madras.

The paper incorporates the results of the recent (April, 1949) Prehistoric Expedition to South Mirzapur (U.P.). Ever since the casual reference to this site situated upon the fluviatile gravel bed resting over the Talchir boulder conglomerate of Permo-Carboniferous glacial origin, in this region by J. Cockburn in 1883 none had attempted to visit much less to explore this inaccessible region.

The collection of palaeolithic tools which are described and classified in this paper, shows, that it is essentially a biface core industry, with a feeble representation of the pebble facies. The chief tool families comprising this industry are the pebble choppers ; Abbevilleo-Acheulian coups-de-poing and cleavers of the straight edged, asymmetric, oblique edged, and triangular types, employing the Attrampakkam (Vaal) technique ;

core and discoid scrapers; flake tools of the proto-levallois type with the striking platform angle ranging from 90° to 125° and some having battered as well as truly facetted right angled platfroms; as also delicate end scrapers. Apart from these, there is a large number of reject flakes in the collection.

Owing to the presence of the palaeolithic tools in the polygenetic gravels of the glacial moraine the exact stratigraphic relationship of this implementiferous fluviatile gravel with the Talchir glacial boulder bed is not clear even though the typological study of the quartzite tools indicates that the industry ranges from earlv to the middle palaeolithic period.

A microlithic industry in quartz without pottery was discovered by the first author about 4′ in the alluvium from top. The antiquity of this is likely to be mesolithic and the industry is characterised, by parallel sided blades, lunates and points.

STONE AGE CULTURES AND CLIMATIC PHASES IN NORTHERN GUJARAT

H. D. Sankalia, Poona.

The field studies of Professor F. E. Zeuner of the rivers of Northern Gujarat indicate that the Sabarmati Abbevillian-Acheulian industry probably belongs to the first wet phase in the Middle Pleistocene. This was followed by a series of two or three drier and wetter phases. During the wet phase preceding the present drier phase, a microlithic industry probably of the Mesolithic Period flourished in Gujarat. (Illustrated.)

BLOOD GROUPS FROM THE ANDAMAN AND NICOBAR ISLANDS

S. S. Sarkar, Calcutta.

During the year 1948 in course of an anthropological survey of the tribal population in the above islands, a number of individuals from the following tribes were serologically grouped. They are as follows :—

	0	A	B	AB	Total
ONGES ..	5	23	2	4	34
JARAWA ..	1	—	—	—	1
ANDAMANESE (Proper) ..	2	12	5	2	21
NICOBARESE ..	117	5	14	0	136

Racial affinities of the Negritos and the Nicobarese have been discussed in the light of the above data.

BLOOD GROUPS OF THE BHILS

Uma Bose, Calcutta.

A survey was undertaken by me in the summer of 1948 among the Bhils of Dhar, Mandu, Sardarpur and Bagh. 534 Bhils were grouped serologically. The percentage of the different groups are as follows :—

0 34.64%; A 28.09%; B 28.09% and AB 9.18%.

The value of p, q, and r are .203, .203 and 0.589 respectively.

The Bhils grouped by Majumdar from Rajpipla, Panchmahal and Khandesh show analogous results.

The Bhils of Nimar who were grouped by Macfarlane (1941) show a considerable difference in their blood groups from all the above samples. Reasons for this divergence are discussed.

Interesting result about the concurrence of serological and linguistic alignments of this tribe is noteworthy.

ANTHROPOMETRIC STUDY ON THE SIKHS OF THE PUNJAB

P. C. Biswas, Delhi.

In this paper the author has incorporated the results of his study on the physical characters of the Sikhs of the East Punjab area. It is based upon the somatometric measurements of 100 male adult Sikhs of that area.

SOMATIC AFFINITIES AND THE RACIAL COMPONENTS OF THE KOLS OF THE CENTRAL PROVINCES OF INDIA

B. K. Chatterjee, Calcutta.

Somatic measurements and observations were taken on 127 male adults and 24 female Kols of the Central Provinces of India, particularly of the Jabbulpur area, during the summer of 1938. The analysis of the somatic data revealed that the basic somatic characters of the Kols are as follows: short stature but having well-proportioned body. The forehead is not very high and the supra-orbital ridges are not very marked. Root of the nose is depressed, and platyrrhinic except when mixed with a higher type. Lips are thick and the chin is retreating. Skin colour is of deep chocolate brown and the eye colour is of dark brown but the form is slightly oblique.

MANUAL DIGITAL FORMULA OF MAN

S. R. Das, Calcutta.

Three different digital formulae have been recorded by the anatomists who have based their conclusions upon the relative positions of the tips of the digits when the manus is laid flat and held right along the long axis. Wood Jones has termed the hands with a formula $3>4>2>5>1$ as primitive, those having the formula $3>4>2>5>1$ as simian and those having the formula $3>2>4>5>1$ as distinctively human.

In course of our studies of the human hand with the help of X-Ray skiagrams, we found that the total lengths of the three phalanges as measured from the base of the proximal phalanx to the tip of the terminal one, show that all the three types of hands mentioned above can be brought under a single skeletal digital formula of $3>4>2>5>1$.

KADAR—SEMANG AFFINITIES

U. R. Ehrenfels, Madras.

Dr. B. S. Guha's establishment of the Negrito strain in the racial configuration of various South Indian hill tribes and also population groups in the plains suggests a racial affinity between the KADAR and the Negritos of Malaya. This racial element is particularly noticeable among the Kadar of Cochin.

1. The ecological basis of Kadar life is a food-gathering and semi-nomadic economy and its technical aspect : leaf-shelters, digging stick, former use of bow and arrow, bark and leaf-dress, bamboo-vessels and tools ("Bamboo-Civilisation"). The similarity of these with the Semang Negritos of Malaya find a particularly clear-cut expression in the stylistic, technical and accidental characteristics of the bamboo combs, such as are being produced and used by both the groups.

2. The social organization is essentially bilateral, among the Kadar, as it is among the Negritos.

3. The religious aspect : a complete Kadar World Creation Myth has been detected. In the course of its description four points will be stressed as relevant to the problem before us; (1) Subterranean Residence of deities, (2) Subterranean Rising of the Waters, connected with deities, (3) Predominance of the female element in the conception of the primordial deities, (4) Changes in the structure of the earth, owing to the action of deities (and the rising of subtreranean waters).

These more than merely accidental similarities in the original mythology of the two groups strengthens the probability of their common origin.

STRUCTURAL FEATURES OF THE KONDH KINSHIP TERMINOLOGY

Gautamsankar Ray, Calcutta.

Very little has so far been studied regarding the kinship terminology of the Kondhs. As regard previous works, excepting the list of kinship terms given by Sir H. H. Risley, practically there is nothing worth mentioning. Further Risley's list is inadequate and cointains some irregularities. This article, which is based upon the kinship terms collected genealogically from Dakpal (a village near Phulbani, the head quarters of the Phulbani District of Orissa), shows the characteristic features of the kinship terminology of the Kondhs of Phulbani area.

SOME OBSERVATIONS ON THE CLASSIFICATORY SYSTEM AS SEEN IN NORTH INDIA AND SOUTH INDIA

Hilda Raj, Delhi.

Classificatory system a feature of society in India.

A general survey of the classificatory system in North India and in South India

Method of grouping relatives on the basis of Kinship.

Kinship terms used in the North and in the South.

Kinship with reference to marriage.

Restrictions and preferences.

Cross cousins and parallel cousins.

Difference between the classificatory system of the North and of the South.

MARRIAGE RULE AMONG THE URALIS OF TRAVANCORE

Bhabananda Mukherjee, Calcutta.

The Uralis inhabit the high hills of north Travancore. Their typical tree houses (*Eru-madam*) can even now be seen in some places.

The characteristic feature of Urali marriage is that it is practised by exchange only. This is called '*Kodutu-marunattu*', meaning barter. The traditional form is to get a wife in exchange of a sister. Previously it was possible to get as many wives as the number of sisters one had. One having no sister remained unmarried. Now the Uralis give any female relation in exchange for a wife.

THE VILLAGE ORGANISATION OF THE KANNIKARS

Jyotirmoyee Sarma, Calcutta.

The Kanikkar tribe sparsely inhabits the reserved forests of the southern and the central sections of the Travancore State. Small groups of Kanikkars stay together in certain well established settlements, the internal appearance of which vary.

In each settlement there is a headman who is recognised as the leader both by the Kanikkars and the forest officials. The headman knows the rules of the important ceremonies and sees that they are kept. He also looks after the welfare of the community, and appeals are brought to him to settle grievances. The power of the headman, however, is not autocratic. The elder man of the community may advise him in regard to all situations, and the headman may change his plans accordingly.

An important aspect of the lives of the Kanikkars is the work to be performed by them for the State. The forest officials give instructions to the headman as to when the work is to be done. The headman passes out the instructions to all and supervises their work.

A NOTE ON AN AUTOMATIC FISH NET—THE KAIJAL

Minendra Nath Basu, Calcutta.

The Kaijal— a kind of automatic fish net collected by the writer from Durgapur village in the district of Jessore, now East Pakistan—a detailed ethnographic account of which is given under the following headings :—

- I. Name, Locality, etc.
- II. Appearance.
- III. Manufacture—including materials, construction, place and time of making, maker, etc.
- IV. Utility—Functions, methods and variations in use, place and time of use, user.
- V. Length of Life.
- VI. Ownership.
- VII. Economic value.

WEAPONS OF WAR AND CHASE OF THE ABORS

Sachin Roy, Calcutta.

In this paper an attempt has been made to study the weapons of war and chase of different sections of the Abors of both the lower and upper regions, extending from N.E.F. of Assam to Tibet Border. This paper deals with : (i) different methods of manufacture of different kinds of weapons used in war, (ii) Poisons of different kinds used with their method of collection, preparation and application of the same on different weapons, (iii) Sex restrictions on the use, manufacture and possession of war weapons. (iv) Right of ownership of the weapons. (v) Use of the weapons of war in the lower region, where the tribe has long given up fighting. (vi) Lastly the paper deals elaborately with the description of each of the weapons with their measurements, methods of use, and the distribution of the different types of weapons among the neighbouring tribes. (Illustrated.)

A section of the paper deals further with different methods of war and chase with different types of weapons used and the ceremonies observed during, before and after the war.

ABOR HOUSE TYPE

Nilima Majumdar, Calcutta.

(Communicated by Dr. S. S. Sarkar)

The paper deals with the description of Abor house. The Abors generally build their houses on slopes of the hills and on platforms. The materials generally used, are, wood, bamboo, cane leaves, palm leaves and cane strips. No iron nails or iron beams are used. The tool that is generally used for the construction of the houses is a 'Dao'. The method of construction is almost similar in different sections of the Abors except in the use of different types of leaves for the construction of the roofs. The house is usually a rectangular type with a single room and a verandah. The re-construction is generally done after four or five years. The construction of the house is generally followed by a simple feast accompanied by a chorus, called 'Bari'. There are dormitory houses "Mosups" for males and "Rasengs" for females. They are different in the construction from that of the dwelling houses.

AGRICULTURE AMONG THE PADAM ABORS

B. C. Gohain, Calcutta.

(Communicated by Dr. S. S. Sarkar)

The paper deals with the agriculture of the Padam Abors—a tribe living on the Tibeto—Assam border on the north-eastern part of India. The Abors are essentially an agricultural people—and the method by which crops are raised is the 'Jhumming' whereby forests are cut and fired and cultivated for two successive seasons before they are allowed to lie fallow for a cycle of years which varies from 9 to 15 years, i.e., accoding to the amount of arable land available to each village.

CLEANING AND PRESERVATION OF LEATHER MATERIALS IN MUSEUMS

Minendra Nath Basu, Calcutta.

This paper deals with the various causes of decay of leather and also with prevention of the causes of decay. Besides various preservatives used by different museums, applications of some indigenous products are also discussed.

Experimental results of 20 leather specimens with different preservatives are also tabulated.

SECTION OF GEOLOGY AND GEOGRAPHY

President :—J. Cates. A.R.M.S., F.G.S.

PETROLOGY

1. A Note on the Reaction Rims in the Olivine meta-norite of Hirapur, Dhanbad.

Y. K. Agrawal, Dhanbad.

The paper gives a description of beautiful reaction rims in olivine meta-norite of a hillock in Hirapur, Dhanbad. Two zones of reaction rims have been observed. The inner one is colourless and consists of enstatite the other one makes the outer green zone and is regarded as being fibrous alkali hornblende. The presnce of the green zone has been observed only where plagioclase felspar comes in contact with olivine or biotite. With the former both the rims are generally, observed whereas with the biotite only the green rim is common.

The rock consists of rhombic pyroxene (hypersthene) diallage, olivine and plagioclase felspar with biotite, magnetite and apatite as accessory minerals. Hypersthene is full of dusty inclusions and is distinctly pleochroic from pinkish to colourless. Sometimes schiller lustre is also observed. The diallage is grey coloured and it is also full of opaque inclusions but is non-pleochroic and shows very fine parting lines parallel to 010. Some of the pyroxenes are recrystallised and are clear of inclusions. The plagioclase shows very fine clouding and zoning. It is found as laths and approaches labradorite in composition. The author considers these reaction rims to be of secondary origin formed during injection metamorphism. The locality from which this rock has been described is quite close to the Damodarpur hillock from which the 'Rapakivi like structure'—a product of felspathisation—has been observed in epidiorites and injection gneisses by N. L. Sharma and Y. K. Agrawal. It is considered that both the structures may be connected with different phases of the same injection phenomena and hence these rims are not strictly corona rims but should be termed 'Relyphitic borders' a term suggested by Schrouf in 1882 for reaction rims of secondary origin due to metamorphism.

2. On the Thermal metamorphism of Impure Dolomitic Marbles in an Area N. W. of Raghunathpur in Northern Manbhum.

A. K. Bhattacharya, Banaras.
(Communicated by D. K. Chakravarti.)

Calc-silicate rocks are exposed as a few, narrow, steeply dipping and isolated outcrops in an area in N. Manbhum, N. W. of Raghunathpur defined by parallels of 23°35′ & 23°38″ N. and meridians of 86°34″ & 86°42″ E. The associated rocks are hornblende-schists, biotite-schists and quartzites of Dharwar age. A small outcrop of porphyritic granite-gneiss occurs near to these rocks in the western portion of the area, while the more or less batholithic exposures of the same rock are found 5-6 miles to the south. The present paper embodies the results of the investigations carried out on the impure dolomitic marbles subjected to thermal metamorphism, presumably due to the grante pluton. A more or less granulitic association of diopside, anorthite, tremolite, sphene, wollastonite, forsterite and calcite in the decreasing order of abundance, is found in the rock nearest the contact, while in the rock a little further away, proportions of diopside and wollastonite increase with a corresponding decrease in those of anorthite and sphene. Still father away from the contact, calcite and tremolite are likewise absent, while the proportions of wollastonite are still more increased with correspondingly marked decrease in those of anorthite and sphene. This shows that wollastonite, in the presence of impurities and under suitable temperature conditions, must have been used up in the formation of other silicates like anorthite, sphene and diopside. The presence of wollastonite ane anorthite in the same rock may represent a false equilibrium as suggested by Harker.

3. A Study on the Gneissose Granites and Associated Metamorphic Rocks of Lohaghat, Almora District.

A. D. Kharkwal, Banaras.
(Communicated by D. K. Chakravarti)

The area covered by this paper lies in the Lohaghat subdivision of Almora District (29°30′ ; 80°00′). The Lohaghat hills form part of the Nag Tibba range of the Lesser Himalayas.

The rock types met with in the area are varieties of gneissose granites, shale and schists. Veins of pegmatites and a band of pyroxene granulite have also been encountered at certain places. Two varieties of gneissose granite have been recognised, viz., the foliated variety and the augen variety. It is the foliated variety which is well developed in this area. It occurs flanked by shale on one side and by schists on the other.

The theory that the gneissose granite of the Himalayas has resulted from the metamorphism of sedimentary rocks is no more tenable. The gneissose granite of Lohaghat is of igneous origin, having developed its foliation, as a result of pressure prior to final consolidation.

The granite has produced marked effects on the adjacent rocks. The shale has been considerably silicified and feldspathised. The schists, on the other hand, have been hybridised by the lit-par-lit injection of the granitic material along their foliation planes. The schists have also undergone contact metamorphism but it does not form a very distinct progressive aureole. It is marked by a wide garnet zone. The augen variety of gneissose granite is interbedded with the schists, and in the field it does not show any connection with the foliated variety. But a petrographical study reveals a genetic relation.

It is not possible to assign any definite age to the granite, because of our imperfect knowledge of Himalayan geology. However, from tectonic consideration, it appears that it is possibly younger than Lower Palaeozoic.

4. Sylhet Trap.

A. B. Das Gupta and V. B. Rao, Digboi.

The stratified traps exposed along the southern edge of the Shillong plateau, named by Medlicott as 'Silhet trap', consists of a series of sub-aerial lava flows which show different degrees of alteration. The common rock types include amygdaloidal and porphisitic basalts and dolerites.

The Sylhet Trap appears to be similar, in texture and composition, to the Deccan Trap and to some extent Rajmahal Trap also. It is interesting to note that pegionite and palagonite which are known to be characteristic of the basalts of the Deccan Plateau are fairly common in the basaltic rocks of the Sylhet Trap.

5. Petrological Studies of Rocks of Borabudur, Java.

C. Mahadevan and N. Sathapathi, Waltair.

A few rock specimens along with two samples of earth, one pebble with a white surface encrustation, and one sample of saline efflorescence obtained from the famous Borabudur monument, were given by Mr. K. R. Sreenivasan, M.A., Superintendent of Archaeology, Government of India, for examination and report.

The monument, from which the above materials have been taken, is built on the summit of a hillock with a central mound. This central mound is cut in to terraces of diminishing size from base to top and cased with massive and well cut stone masonry. The monument is leaky and water sinks through the pores and joints of its structural blocks which are a kind of vesicular volcanic rocks.

The specimens were studied by physical, microscopical and, qualitative and quantitative chemical methods. The results of the quantitative chemical analysis have been graphically represented. The results of these investigations have yielded the following information, The rocks are of andesitic composition belonging to the pacific suite and most probably obtained from the andesitic lava beds of the area. They do not show any appreciable amount of alteration and the saline efflorescence is carbonate of lime deposited by percolating water which might have brought it either from the decomposed central core of the mound or from the lime mortar packing, if any, employed during the construction. However, there is no indication to show that the saline efflorescence has been derived from the decomposition of the structural blocks.

So it is concluded that the structural material of the monument does not show any signs of decomposition. Suitable measures may be taken to prevent rainwater sinking into the monument.

6. A Comparative Study of the Trap Rocks of the Shimoga and Chitaldrug Schist Belts, Mysore State.

C. S. Pichamuthu, Bangalore.

The Shimoga and Chitaldrug Schist Belts are two of the most prominent Dharwar bands in Mysore State. Forming part of these schist bands are basic flows and intrusions which have been described as traps. In the Shimoga Belt, there are the Lingadhalli and Santaveri traps, and in the Chitaldrug Belt, there are the Jogimardi, Chitaldrug, and Bellara traps.

In this paper, petrographical descriptions of these rocks are given. Seven chemical analysis of the traps have been used for the study of their petrochemistry. The C.I.P.W. norms, Niggli values, Basis molecules, and Kata-molecular norms have been calculated. Four diagrams in which recalculated values are plotted serve to bring out the points of similarity and divergence.

7. Spheroidal Weathering at the Waltair Coast.

N. Sathapathi, Waltair.

Various views have been advanced in recent years to account for the spheroidal weathering of rocks. The author has studied in detail spheroidal weathering observed in the charnockites of the Waltair Highlands and charnockite stacks along Vizagapatam beach and comes to the conclusion that causes like formation of new minerals such as crystallisation of salts in the microcrevices of rocks and simple hydration of mineral constituents of rocks are also capable of bringing about spheroidal weathering.

An attempt has also been made in the paper, to interpret spheroidal weathering in the light of fabric study of the fracture planes and contact planes of mineral constituents of the rock.

By such a study, it was found that the develpment or the non-development of shells in the process of spheriodal weathering is controlled by the ratio of the intermolecular cohesion of minerals and cohesion at the contact planes of minerals. To a certain extent, this is also controlled by the granularity and size of the rock.

8. A Note on the Cordierite-bearing Vitrophyric and Hornfelsic Rocks of the Ramnagar Area, Raniganj Coalfield.

N. L. Sharma, Dhanbad, *and* R. C. Misra, Lucknow.

These rocks are associated with the burnt outcrop of the Laikdih coal seam of the Ramnagar area. They are dark coloured, compact or vesicular, rocks resembling hornfels and vitrophyre in hand specimens. Under the microscope, they show a remarkable development of idioblastic cordierite. The mineral occurs as fantastically shaped crystals wrapping round or enclosing, partly or completely, the glassy matrix. It exhibits a strong tendency to develop idioblastic crystals, showing square, rectangular, lath-shaped and hexagonal sections, retaining still in the core the glassy matrix oropaque inclusions. In some varieties, the cordierite crystals have been able to clear themselves of these inclusions. The groundmass of these rocks is dark grey or yellowish brown in colour, and is often devitrified showing dendritic rods of magnetite and colourless needles of nascent cordierite. Pink or purple spinel occurs in the groundmass as small interspersed grains, and sometimes octahedra of it are observed as inclusions in the otherwise clear cordierite crystals. Xenoliths of rounded granules of quartz are common in these rocks, Specimens of rocks resembling blue spherulitic obsidian, black glassy obsidian and dark vesicular pitchstone have also been collected. The blue rock shows under the microscope dark brown and yellowish brown bands, the latter are fluorescent, showing yellowish brown colour in transmitted light and blue in reflected light.

All these rocks have evidently been produced as a result of the vitrification of the shales of the Barakar series by the intrusion of the mica-lamprophyre associated with the Laikdih seam. A detailed study of the specimens is in progress.

9. Myrmekitic Structure in the Granites of Bagru Plateau, Lonardaga, Ranchi District.

R. C. Sinha, Banaras.
(Communicated by D. K. Chakravarti)

The writer wishes to record here for the first time the occurrence of myrmekitic structure in the granites of the Bagru Plateau to which no reference has so far been made. Megascopically the rock is leucocratic, medium to coarse grained with highly altered felspars. The flakes of biotite are also promimently visible to the naked eye. The sp. gr. is 2.62. Under the microscope the minerals recognised are quartz, orthoclase, oligoclase, biotite, chorite, apatite, kaolin and sphene. The quartz with its usual characters occurs as xenomorphic crystals and as lace-like vermicular intergrowths with the oligoclase thereby showing the myrmekitic structure. Orthoclase is altered to kaolin and appears to be replaced by oligoclase showing lamellar twinning and extinction angle varrying from 8 to 12°. Besides, the orthoclase pieces are still found lying by the side of the oligoclase with typical quartz inclusions. Laths of biotite are also found adjoining such felspar pieces. The percentage composition of the various minerals in the rock is as follows :—

Quartz ..	.. 33.70%	Oligoclase (and secondary albite)	24.50%
Orthoclase	.. 27.70%	Biotite	6.31%
	Accessories	.. 6.82%	

The development of myrmekitic structure is ascribed to different processes by different authors such as Sederholm, Holmes, Bowen, Alling, etc. In view of the microscopic observations recorded here the present author feels that these intergrowths of vermicular quartz and oligoclase are due to albitisation caused by hydrothermal solutions as advocated by Holmes.

10. On the Occurrence of Gabbro at Dhab, Hazaribagh District, Bihar.

R. C. Sinha and V. D. Shukla, Banaras.
(Communicated by D. K. Chakravarti)

This paper records the occurrence of gabbro at Pandaria near Dhab (24° 35′10″ ; 84° 45′30″), a mica-mining centre situated at a distance of 22 miles from the Kodarma Railway Station (E.I.R.). The rocks are exposed over an irregular elliptical area, one mile by half a mile. Other rocks in the adjoining area are epidiorites, granite-gneiss and schists.

Megascopically, the rock is dark in colour with tabular pieces of hornblende and white to grey looking interstitial plagioclases. It is a holocrystalline, coarse to medium-grained rock with a specific gravity of 3.00.

Under the microscope the texture is coarse-grained, hypidiomorphic and equigranular, the size of the grains is between 5.5 and 6.5 mm. The minerals are labradorite approaching bytownite, hornblende, biotite, albite, seconday quartz, iron-ore, orthoclase and epidote along with other accessories. The micrometric analysis gives the percentages of the above-mentioned constituents as :—

Labradorite—	44.75% ;	Hornblende—	40.54% ;	Biotite—	1.48% ;
Albite—	4.65% ;	Quartz (secondary)	3.67% ;	Iron-ore—	1.42% ;
Orthoclase—	1.33% ;	and Other accessories—	2.27%.		

The chemical analysis of the rock is as follows :—

SiO_2	.. 50.12	Al_2O_3	.. 17.86	Fe_2O_3	.. 2.18
FeO	.. 7.93	CaO	.. 12.03	MgO	.. 4.69
Na_2O	.. 2.95	K_2O	.. 0.83	H_2O	.. 4.69

It compares well with the mean of the average analysis of 41 gabbros from different parts of the world.

11. A note on the Petrology of the Basic Intrusive Rocks of Gomoh, Bihar.

N. V. R. Subrahmanyam, Dhanbad.
(Communicated by N. L. Sharma)

The area just north of Gomoh Railway Station (on the E.I.R. Grand-chord line) has been surveyed geologically. The country rock is greyish-pink and much weathered felspathic and hornblende granulitic gneiss, occupying low-lying tracts in the area. The predominant direction of strike of the country rock is east-west but it is locally affected by the larger intrusives. The country rock is much foliated, the plane of foliation dipping slightly from vertical towards north.

The basic intrusives in the area stand out prominently as hills. One such hill, extending east-west for about one and half miles, occupies a central and prominent position. Other hilly outcrops are comparatively small but are conspicuous in ranging themselves in a detached fashion, around the main hilly prominence, suggesting more or less the shape of ring-dyke-like intrusions.

The hilly outcrops are composed of dark and compact rocks, which on closer examination reveal heterogeneity in the granularity, mineral composition, and degree of metamorphism. These intrusive basic rocks include rock types such as meta-gabbro and meta-norite, meta-dolerite, epidiorite hornblende schist and pyroxenite, not only exhibiting different stages in the metamorphic processes of mineral transfromation, recrystallisation and granulitisation among themselves, but also revealing certain stages in the process of hybridisation. A low hillock, north of the main hill, consists of quartz-schist, which is considered to be a metamorphosed intrusive quartz vein.

Correlation of the different intrusive rocks based upon their field relationships, chemical composition, mineral assemblages and degree of metamorphism, is under active investigation.

12. Heavy Mineral Sorting.

V. B. Rao, Digboi.

During the examination of the samples collected for determining the heavy mineral assemblage, several thin dark coloured layers, abnormally rich in heavy minerals, were noticed in some of the samples from the Dhekiajuli Beds of Upper Assam, which appear to be referable to the Dihing Series. These dark layers contain as much as 30% of heavy mineral residue, compared with an average yield of between 2 and 4% from samples which are devoid of dark layers. Such concentration or 'flooding' appear to be due to frequent agitation, by water and/or wind currents, of the superficial layer of a shallow water fluviatile formation, during deposition.

In spite of the concentration of heavy minerals in the darker layers of the rock samples, there is a large reduction in the proportion of some of the diagnostic heavy minerals, like Hornblende, Epidote, Hypersthene, etc., which are usually present in fair quantity in the lighter layers of the same rock. Comparison of analyses of samples from the dark and light layers of the same rock suggests that this diminution in the proportion of the diagnostic minerals is due to a large increase in the proportion of the heavier opaque minerals like Ilmenite and Magnetite in the darker layers. It is, however, interesting to note that there is practically no change in the percentage of Garnet, which has a specific gravity intermediate between that of the 'opaques' and the other diagnostic heavy minerals listed above.

ECONOMIC MINERALS

13. Study of Ore Minerals by the "Contact Print" Method.

N. N. Chatterjee, Calcutta.

The important properties hitherto used for the identification of opaque minerals under the reflecting microscope are colour, hardness, isotropism, anisotropism, reflecting power, electrical conductivity, etch tests, micro-chemical tests, staining tests etc. But each of the above properties has limitations in its application for specific identification. Moreover, it is not possible to localise the elements in the specimen. By following the new "Contact Print" method the localisation and distribution of the elements in a specimen can be done and preserved for future reference. Coloured contact prints will show faithfully the location and distribution or different elements in different colours. Another advantage of this method is that even in the grains of very small size say 200 mesh the elements can be detected by coloured prints.

The work in this new line was done in the Mining Geology Dept. of the Imperial College of Science, London, under the guidance of Prof. D. Williams. The author remains in deep debt of gratitude to Prof. Read and Williams for giving him all facilities in the laboratory. Thanks are also due to Mr. Nakhla for his constant help. The electrographic process was employed in all cases to get the best results and bakelite graphite mix was used for mounting specimens.

Results of experiments on minerals like niccolite, pentlandite, pyrrhotite, chalcopyrite, cobaltite, violarite etc. are given in the paper. The attacking and specific reagent for nickel was ammonia and alcoholic solution of dimethylglyoxime and pink coloured print was obtained. The reagent for copper was ammonia and alcoholic solution of alpha-benzoinoxime and green print was obtained. The reagent for cobalt was ammonia and alcoholic solution of benzinediazole and violet colour was produced. The reagent for iron was dilute nitric acid and sulpho-salisylic acid and violet coloured print was obtained. The period of digestion of the photographic paper in the reagents was 60 seconds in all cases and the period of contact varied between 25 and 30 seconds. Electric current of 6 to 12 volts was applied. The coloured prints will be exhibited at the meeting.

14. A Comparative Study of a Sample of Lignite from Jodhpur, Rajasthan.

P. K. Chatterjee and R. B. Ghosh, Calcutta.

An occurrence of lignite has been recorded while digging a well on the Orllagi-Undra Road near the Jodhpur-Jaisalmer border. This place is about 40 miles west of Sheo (26°12′ : 71°15′) on the north-western part of Jodhpur State.

A well of 3 feet diameter was sunk up to a depth of 350 feet from the surface and the lignite bed was struck at an approximate depth of 330 feet continuing for another 10 feet down below. A sample of this lignite, obtained through the courtesy of Mr. S. K. Borooah, formerly Director of Mining and Geology, Jodhpur State, has been studied in the laboratory of the Geological Survey of India. The material is hard and massive with dull black colour and shining lustre. It has a specific gravity of 1.25. When broken it gives rise to conchoidal fracture and thin laminations are seen. Woody texture is still visible. On chemical analysis it gives the following : Moisture—13.68% Volatile matters—39.28%; Fixed Carbon—40.92% and Ash—6.12%. From this it appears that the material has a fairly high volatile content but remarkably low ashr A comparative study of the characters of this material with those obtained from othes occurrences in India has been made.

15. Occurrence of Sedimentary Clay in the Neighbourhood of Baldekhal and Champamura Hills, near Agartala, Tripura State.

S. Deb, Calcutta.

Highly plastic mottled clay of sedimentary origin occurs in the neighbourhood of Agartala, Tripura State. Detailed prospecting work has been carried out in this area by the author and about a dozen trial-pits have been dug to know the extent of deposits. The total approximate reserve of different varieties of clay occurring in Champamura hills is 50,000 tons. In the Baldekhal area adjoining the Champamura hills, the reserve is about one million tons. There are other exposures which require further detailed prospecting. The geology of the area has some similarity with the Tertiary sequence of N.E. Assam. It is probable that the low hill ranges of S.E. Agartala are homotaxial with the Tipam Sandstone Series of Upper Assam.

The clay has been derived undoubtedly from the granitic or gneissic rocks found in the Archaean complex of Shillong and other regions of Assam. It is presumed that in the Miocene period a sheltered arm of a sea used to exist in this area, where sediments of clayey and sandy nature were deposited at the bottom of the basin.

Optical and physical properties of the clay have been determined. Clay minerals of kaolinite-anauxite group have been recognised. The chemical analysis also corraborates the same nature of the clay substance. When burnt, the clay appears to be very refractory in character and turns into a semi-white cream coloured mass at 1250°C. It does not show any sign of fusion at the temperature. By reducing the plasticity, the clay can be moulded into very fine china-ware with slightly stained surface. The installation of a washing plant and a ceramic factory in the neighbourhood of Agartala has been recommended.

16. The Possibility of Utilisation of Carbonaceous Shales for the Manufacture of Portland Cement.

R. Ghosh and P. K. Ghosh, Calcutta

Coals with ash-content over 30% find little use in any industry. They are classified according to their ash-content as shaly coals, carbonaceous shales etc. In coal seams they occur in bands or layers varying in thickness from 2″ and over or even less. During extraction they are separated from good coal and generally stacked in open places adjoining collieries. Due to atmospheric oxidation these hugestacks of waste material catch fire and often becomes a danger to the coal seam itself. Some of the carbonaceous shales burn to a white ash. The clay complex of ash would furnish the requisite material and would serve the purpose of clay required forthe cement mixture. Besides supplying the clayey matter these would supplement the heat required for clinkering the cement mixture. The use of these white burning carbonaceous shales for manufacturing white cement would find an outlet for the utilisation of these waste materials.

17. Mineral Resources of the Damodar Valley and Adjacent Region and their utilisation for Industrial development.

V. R. Khedker, Calcutta

The Damodar Valley Project encompasses portions of Bihar, Orissa and Bengal and lies in a region which abounds in rich deposits of economic minerals. This account presents all available statistical data in the possession of the Geological Survey of India, especially the reserves of minerals and the amounts spent by India on imports.

The following minerals, mineral assemblages or rocks which serve as raw materials for industry or have some commercial application occur in the Damodar Valley and adjacent region. Abrasives, apatite, asbestos, barytes, bauxite, chromite, clay, coal, construction materials, copper ore, gold iron ore, mica, mineral fertilisers, mineral springs, ochres, refractory materials, salt, silica, steatite, sulphur and vanadium ore.

The imports into India of capital and consumer goods in the manufacture of which minerals are utilised, amount to about Rs. 700,000,000 annually.

The primary object of this work is to assess the reserves of mineral wealth in terms of development of new and expansion of existing industries.

The pattern of integrated industry utilising minerals as raw materials resolves into two groups : (1) Metallurgical—non-ferrous and ferrous ; (2) Non-metallurgical chemical, heavy chemical, cement, ceramic, refractory, insulation, glass, paints and pigments. Products of both these groups ultimately enter into the production of capital machinery and consumer goods.

This pattern of industry unfolds great potentialities capable of being developed and mobilised with help of research, planning and organisation under a system of exploitation in the best interests of the nation.

18. Refractive Indices of Vitrain as an Index of Rank.

K. C. Lahiri *and* R. N. Basu, Digwadih.

In petrographic studies attempts have been made to measure the degree of coalification based on quantitative optical tests. It has been found by previous workers that the index of reflection is inversely related to volatile-matter content. In this study also refractive indices of polished vitrains from Indian coals have been determined and correlated with the rank of coals. A Reichart horizontal-circle goniometer fitted with suitable accessories and a Leitz polarisation apparatus were used for the determination of the Brewster's angle.

Vitrains from the following seams were examined :—

Namdang (Tertiary coal, Assam), R.I., 1.702 ; Karkata seam (Karanpura) R.I., 1.708 ; Dobrana seam (Ranigan) R..I, 1.709 ; Argada seam (Karanpura) R.I., 1.741 ; No. XVI and No. XIV seam, R.I., 1.760 and R.I., 1.786 respectively ; No. XI seam R.I., 1.817 ; and No. VII seam, R.I., 1.842. The last four from the Jharia field are of special interest. The carbon contents (on pure coal basis) are as follows : No. XVI, 86.60% ; No. XIV, 87.80% ; No. XI, 88.80% ; and No. VII, 89.50%.

It is observed that for the seams of Jharia coalfields a straightline relationship exists between the refractive indices and the carbon contents of vitrain specimens obtained from these seams. These coals are of coking quality. In other words, increase in rank is accompanied by an increase in refractive index. Thus, in the seams of the Jharia field refractive index increases with the depth of coal seams in much the same way as fixed carbon increases (Hilt's Law).

The results, although not extensive enough to justify generalisation, indicate that there is a probable relationship between rank and refractive index of coals from the the same horizon in the same coalfield. Further work on these lines and on refinements in determination of the maximum angle of polarisation is being continued.

19. A Reconsideration of the Economic Aspect of the Chhakkarbandah Tin Deposit, Gaya District, Bihar.

N. K. Mukerjee, Banaras.

Mr. D. C. Nag, the discoverer of the Chhakkarbandah Tin Deposit, has shown in his estimate that the above-mentioned deposit is profitable even when 1% of cassiterite is available from the crude ore. But the present writer, in course of his field-study in the area, has found that mining for cassiterite is carried on by crude country-made inplements for which the production of ore is almost negligible and the cost of production is too high. In an estimate, it has been shown that actually there is a loss in continuing the project even when the most successful trial pit of the area is yielding an ore containing .5% of cassiterite. There are major problems of labour, machinery, power, water and communication together with other minor difficulties in the area. The most important problem is that of machinery, and without proper machinery, the production ot in-ore cannot be raised up. Moreover, the area has not yet been very thoroughly studied from the geological point of view and, therefore, it is not yet possible to ascerain the exact quality and quantity of the ore-deposit of the area. In the opinion of the writer, the tin deposit of Chhakkarbandah should be critically examined first and then if it is found promising, mining with proper machinery should be started.

20. The Source of Manganese in the Manganese Ores of Mysore.

B. P. Radhakrishna, Bangalore.

Detailed mapping of the Chiknayakanhalli schist belt has shown an invariable association of manganese ore bodies in the area with the basal position of limestone beds. Analyses of these limestones especially from the basal portions reveal a richness in manganese, varying from 2.5 to 10.0% of MnO. It is concluded that the manganese ores are formed by the weathering and replacement of the lowermost beds of limestone which are manganiferous and that a distinct stratigraphic horizon containing manganiferous dolomites can be recognised in the schist belt.

21. Mica of Mewar.

R. V. K. Rao and S. K. Goel, Mewar.

Mica of good quality occurs in the Toonka, Chondawas, Amli, Sidriyas and Malola mica mines in Mewar State. Generally the mica is a ruby variety of muscovite, but a green variety and phlogopite are also found.

STRATIGRAPHY.

22. Is the Semri Series in Bundelkhand Bijawar or Lower Vindhyan ?

V. S. Dubey, U. S. Sanwal, and K. C. Joshi, Banaras.

The Semri Series and the other formations of Bundelkhand have been studied and mapped for about 40 miles. Here the Semri Series consists of quartzite, porcellanite, black shale, quartzite with limestone and shales overlaid by thick bed of Kaimur Conglomerate mostly made of jaspers. The thickness varies from 100 feet to zero feet near Panna town. Porcellanite rock of this series are definitely silicified basic tuffs.

The similarity of the Bundelkhand Semri Series with typical Bijawar area two miles away, presence of basic igneous rocks and jasperiodal rocks, great unformity between this Series and overlying upper Vindhyans and absence of jaspers from the Basal Conglomerate tend to show that this Semri Series in Bundelkhand should be better assigned to a part of the Bijawars. In the opinion of the writers Vindhyans in this area being with Kaimur Conglomerate followed by Kaimur Sandstone as is the case near about the typical Gwalior area.

The study of this and the surrounding area shows that this Series containing basic rocks was followed by ultrabasic rocks containing diamonds. The igneous cycle ended by intrusion of granites, acid-dykes and possibly by flows of rhyolites at the end of Bijawar period and in pre-Vindhyan times.

23. On Buried Gondwanas near Jubbulpore, C.P.

K. K. Dutta and A. K. Roy, Calcutta

The paper deals with an inlier of Gondwanas struck while boring for water in Marotal village (79° 54′30″ : 23° 12′), about one and a half miles northwest of Jubblepore, C.P. The area round Marotal village consists of alluvium, which hitherto was believed to be lying over granites and granite gneisses. But the boring proves that this is not so. Inliers of Gondwanas also do occur buried underneath the alluvium. The strata chart of the above shows that the alluvium here is about 60 feet thick, succeeded in descending order by about 10 feet of laterite, 38 feet of white clay and the rest down to a depth of 145 feet medium to coarse grained friable Jabalpur sandstone. The rocks have been described and their relation established with the Jabalpure grits ccourring in the Jubblepore Cantt.—the type area.

24. A Note on the Inter-Trappean bed at Doddihal, Bijapur District.

K. V. Kelkar and Y. S. Sahasrabuddhe, Poona.

The note describes the inter-trappean bed at Doddihal (16°24′; 75°33′), which is one of the three known fossiliferous inter-trappean beds in the Southern Mahratta in Belgaum District, [illegible]

The Doddihal inter-trappean rock is a calcareous sandstone consisting chiefly of quartz, fragments of fossil shells and calcite, and a small amount of feslpar, chily-microcline. The accessories in the rock are : ilmenite, haematite, zircon, tourmiline garnet, epidote, hornblende, more or less chloritised biotite, and a few grains of apatite rutile, sphene, kyanite and staurolite. The fossils are : shells of Bullinus (Physa) prinsepii and a few of a Lymnaea closely resembling Lymenaea attenuata of Hislop.

The Upparhatti and Mamdapur beds also consist of calcareous sands made up of quartz, shell fragments and calcite, and a few grains of microcline and turbid felspar, and contain iron ores, garnet, epidote, tourmaline, zircon, hornblende, actinolite, kyanite, staurolite, rutile and apatite as accessories. The accessories are almost identical with those occurring in the Doddihal bed. The fossils in these beds include a few shells of Bullinus (Physa) prinsepii of a species of Indonaia, and of a variety of Potomida favidens ; and some shells of Lymnaea closely resembling those in the Doddihal bed There are also present a number of shells of Ena (Subzebrinus) sindica (Reeve).

25. The Correlation of the Gondwanas (?) of the Guntur District by Sedimentary Petrographic Methods.

M. Poornachandra Rao, Waltair.

On the coastal region of some of the Circar Districts of Madras Presidency outliers of sheets and patches of sandstones and shales outcrop in several localities, some out of which are fossiliferous but most of them are devoid of any recognisable organic remains. Some of these are in the Ongole area, others in the Guntur area and yet others near Rajahmundry and environs. The sandstones of the Rajahmundry area in Godavari District are surmised to be homotaxial with the Cuddalore sandstones and thus relegated to Tertiary age. The sandstones and shales near Ongole were relegated to the Upper Gondwana Series from fossil evidence. In the intervening area, the patches and spreads of sandstones (and occasionally shales) which are devoid of fossils, present difficulties with regard to their correlation and were thought by Bruce Foote to be homotaxial with the Upper Gondwanas. This paper is an attempt to tackle the problem by methods of sedimentary petrography. From a careful study of the results it is established that the doubtful rocks in the Guntur area show greater affinity to the Tertiary formations of Rajahmundry area and great divergenee from the upper Gondwana formations of the Ongole group of rocks.

26. A Study of the sedimentary Formations of the Coastal Region of East Godavari District.

S. Sriramadas, Waltair.

A reconnaissance survey has been made in the coastal region of East Godavari District and in parts of Vizagapatam District. Outlies of sandstones are noticed in several localities. The disposition of these formations is a matter of uncertainty as they are mostly covered with soil and exposed here and there in quarries for road metal. Some are highly ferrugineous indurated fine grained red sandstones. Others are coarse to conglomeratic in nature and some buff to white coloured and are argillaceous. In one locality the sandstones are highly fossiliferous though the fossils are badly preserved.

The paper records the preliminary results of the study of these rocks by sedimentary petrographic methods with a view to assign them to their proper stratigraphic horizon.

27. Geology of Karempudi and Durgi Areas Guntur District.

G. V. Umamaheswara Rao and K. Kondaiah, Waltair.

The study of the stratigraphic position of the Palnad formations in parts of Guntur district has been taken up for the last three years in the Andhra University. In the previous communications on this subject by previous workers of the Geology Department evidence was adduced to suggest an angular unconformity between the uppermost Cuddapah beds and the Palnads, the latter being surmised to be homotaxial with the Kurnools. The authors of this paper working in the Karempudi and Dugri areas have mapped in detail the members of the Purana group which cover the whole of this area (G.T. Sheet 56P/11). A detailed study brings out the following important facts ;

(1) The repetition of some of the beds in the Cuddapah formation are shown to be due to an overfold and some of the anomalous observations noted by the previous workers from the department are easily understood in the light of this evidence.

(2) The analytical data about the nature of the limestones in the area confirm the inference of an uncondormity.

(3) The Palnad Series in this area is shown to consist of a basal conglomerate grading into sandstones, shales and finally to limestones.

These limestones have the greatest resemblance to the Nerjee limestones of the Kurnool group. These observations take us a step further in the elucidation of the statigraphy of the Palnads.

28. Geology of the Area between Law, Lemalle, and Nirukonda Hills, Guntur District.

Rama Krishna Rao, Banaras.

(Communicated by D. K. Chakravarti)

The geological formation of the area were studied in detail both in the field and in the laboratory. The physiographic features are described elaborately. Much of the area is covered by Black Cotton soil. The rock formations crop out mainly along side the road, Guntur-Amaravathi. The rock types recorded in order of abundances are : 1. Granites, 2. Charnockites, 3. Leptynites, 4. Pegmatites and Quartz vein 5. Quartzites and Spotted-Slates. Migmatites and other hybrids also were noted. Ultrabasic, basic and intermediate types of Charnockites occur, of which the basic type is predominent, while acidic type is absent. The Granites show evidence of assimilation of the pre-existing Charnockites and the granitic intrusion is responsible for the production of various hybrids and migmatites. It is suggested that the basic Charnockites were originally of igneous origin, while the ultrabasic types were produced by the excessive development of Hornblende as a result of the interaction between Hypersthene and Plagioclase, a metamorphic reaction. (Photo-Micrograph) The intermediate types seem to have evolved as a result of marginal granitisation of the basic Charnockites. The Leptynites are surmised to be the reconstituted Khondalites affected by the intrusion of basic Charnockites. Economically, the area is not of much importance except for building stone and road metal.

PALAEONTOLOGY

29. Microfossils from the Cambrian Strata of the Salt Range, Punjab.

A. K. Ghosh and A. Bose, Calcutta.

Gee suggested that the micropalaeontoligical examination of control rock samples from the Cambrian strata of the Salt Range of the Punjab may be helpful in explaining the wide occurrence of Tertiary microfossils in the infra-Cambrian Saline Series. A preliminary report on the examination of control samples of undisputed age was communicated by the authors in a previous session of this section. Since then a number of such samples, collected by the B.O.C. (I.C.) Ltd., are being examined by the authors and the following micro-fossils in addition to the previous findings are listed. Samples called ' Black" are from 1 ft. inside the rock surface, those called "Red" from the surface.

(1) *Purple Sandstone*—Sample No. 6, Black and Red, Sandstones, from Warcha gorge, yielded carbonised and non-carbonised pieces of wood showing uni-multiseriate simple pits, scalariform and bordered pitted tracheids ; cuticles, a few Sports, and insect remains.

(2) *Neobolus shales*—Sample No. 7, Black and Red, fine grained greenish sandstone from the locality of No. 6 and Sample No. 8 Black calcareous sandstones, from Chittidil, yielded carbonised pieces of wood showing uni-multiseriate simple pits, pit relics, non-carbonised woods with or without pits ; and a few spores.

(3) *Magnesian sandstone*—Sample No. 9, Black, light grey micaceous sandstone from the locality of No. 8 yielded carbonised bordered pitted and scalariform tracheids, single pitted pieces of wood, and non-carbonised wood elements with simple or bordered pits, or without pits ; and cuticles with stomata.

(4) *Salt Pseudomorph Beds*—Sample No. 10, Black and Red, sandy shale (not a typical sample) from the locality of No. 8, yielded structureless pieces of carbonised woods, scalariform and simple pitted tracheids ; a few cellular structures, membranes, etc.

The occurrence of vascular plants in the Cambrian beds is not in conformity with the known fossil records, and yet remains to be explained by further extensive investigation which is in progress.

30. The Stratigraphical Value of Miscellanea and Pellatispira in Pakistan, India, and Burma.

Y. Nagappa, Digboi.

In the Eocene of Pakistan, India and Burma, two genera-*Miscellanea* and *Pellatispira*—have shown a remarkably stable and limited vertical range in the several areas in which representatives of these genera are found. *Miscellanea*, which is represented by *M. miscella*, *M. stampi*, and *M. meandrina*, is confined to the Upper Ranikot (*Palaeocene* age) in all the areas examined so far, while *Pellatispira*, which is represented by *P. orbitoidea*, *P. infata*, *P. madaraszi var indica* and another species which may be new, is found only in the very high Eocene (Upper Eocene—mostly Bartonian) beds. Because of their very restricted vertical range these two genera have a considerable stratigraphic value.

31. More Dasycladaceae from the Niniyur Group (Danian) of the Trichinopoly Cretaceous, S. India.

L. Rama Rao, Bangalore.

In the Memoir on the "Fossil algae from the uppermost Cretaceous beds (the Nimiyur group) of the Trichinopoly District, S. India" (L. Rama Rao & Julius Pia : Pal. Indica N.S. Vol. XXI, No. 4, 1946) an account was given of the *Dasycladaceae* occurring in the Niniuur group ; and practically all these were found in the chert bands near Nattagooly. A further collection has since been made of similar cherts from other parts of the area, and sections of these reveal an extraordinarily rich abundance and variety of *Dasycladaceae*, including several new forms not described in the 1939 memoir. The entire material is exceedingly well preserved.

32. Note on a Fossil Find from the Inter-trappeans of Dongri, Salsette Island Bombay.

R. N. Sukheswala and D. N. Elchidana.

This paper is written to put on record the occurrence of a fossil fish in the Inter-trappeans of Dongri, s small village situated in the north-western part of the Island of Salsette, Bombay.

This part of the Island consists of hill masses ranging to a height of about 309 feet. The dominant rock types constituting these hill masses are the rhyolites together with minor associations of ash-sedimentaries (Inter-trappeans), massive ash, and trachytes.

The bed which has yielded three specimens of fossil fish together with impressions of scales is formed of ash material of volcanic origin. The bed is hardly 4 feet thick and very limited in extent. The fossil specimens as identified by Hora reveals the following characters :

The fossil fish belongs to the sub-order Percoidei in which the fins are provided with spines and the ventral fins are thoracic. It is likely that they belong to the family Apogonidae which in its distribution is from Eocene to Recent. Fossil scales are identified to be of the Ctenoid type which also show that the fish may have been of the sub-order Percoidei.

Chemical analyses of rhyolites and trachytes are added and field relations and laboratory data help us to establish some sort of genetic relationship between the various rock types existing in the area.

MISCELLANEOUS

33. Studies in Pleistocene Glaciation in the Eastern Himalayas—I.

N. R. Kar, Calcutta.

The paper embodies the results of investigations arising out of field work on glaciologic lines carried on a part of Eastern Himalayas which have led to the recognition of a Pleistocene glaciation on a gigantic scale attended with all the sedimentologic features of an Ice-Age. Evidence along geomorphic, petrographic, glacio-fluvial lines has been adduced which proves beyond doubt an advance of a huge glacial lobe encroaching from over Central Himalayas down to an altitude of 500 feet in the North Bengal Plain. Occurrence of huge erratic boulders, unassorted 'till-fabric', morainic topography, drumlin formations, terminal moraines, glacial pool and the likes have been indicated. Shape and form analyses of several hundred drift boulders selected at random have yielded interesting results confirming the earlier findings of Von Engeln (1930) and Wentworth (1936). Evidences of several glacial periods separated by 2 to 3 inter-glacial phases have been put forward from the study of weathering differentiations and englacial and sub-glacial stream-terraces.

34. Spontaneous Polarisation Survey of the Kunchiganhal Block of the Sulphide Zone of Chitaldrug, Mysore.

A. S. Narasimham, Madras.

Geophysical principles are important in economic geology and date obtained from geo-physical survey of a mineral ised region are far more reliable and precise than two decades, ago. Geo-physical science has advanced so vastly that it has become a necessary help to economise on the initial cost of prospecting operations based upon surface geological mapping alone.

As an instance, spontaneous polarisation data obtained in a block of the sulphide zone of Chitaldrug (Mysore), known as the Kunchiganhal block are presented in graphs of s. p. (spontaneous polarisation) curves and e. p. equi-potential) contours, the latter being embodied on the geological plan of the block. Two centres of maximum potentials are indicated, where at prospecting operations are expected to yield favourable results. The depth of the orebody and their shape is also calculated from the survey data. The interpretation of the s.p.e.p. lines with reference to this particular field is also attempted.

GEOGRAPHY

35. Mohanpur Hana : A Spill Channel of the Damodar.

S. C. Bose, Calcutta.

Mohanpur Hana is a wayward spill channel of the Damodar, running south of it, 12 miles below Burdwan. After 1943 it became very destructive, and destroyed thousands of acres of arable land. It washed away villages, inundated cultivated fields spread sand over paddy land and created havoc unchecked and unbridled. A hydrological study of the area was carried out, and the construction of a cross-bund suggested, the work being completed in May 1948. It has proved to be a success. A sum of Rs. 1 lakh was spent. It yielded crop worth Rs. 13,50,000 in 1948. A crop worth Rs. 22,25,000 was expected in 1949. The experiment having proved successful, it is suggested that similar bunds be constructed across the mouths of other spill channels in this area.

36. Topographic Changes in the Littoral Tracts of Midnapore, West Bengal.

Monoranjan Chaudhuri, Calcutta.

The Littoral Tracts of Midnapore present interesting physiographic features. The whole area is covered with sand dunes. As one approaches Contai, one comes across a sandy ridge, known as the Contai ridge, which runs from near Contai and continues through Orissa. Another Sandy Ridge runs parallel to the Sea Coast near Ramnagar. The wind is the most active agent of erosion modifying the natural landscape of the area. The sand dunes are migrating into the interior and hence are giving rise to agricultural problems. The predominance of quartz elements and absence of minerals in the sand-dunes indicate that the process of erosion is fairly slow. The work of the wind is more prominent than the work of the sea. Planting of defensive vegetation can alone fight the menace of wind erosion and migration of sand-dunes in the area.

37. Regional Delineation in Madras Province.

V. L. S. P. Rao, Calcutta.

The paper embodies some observations on regional delineation in Madras Province. The delineation offered in this paper is based on geographical and statistical methods.

The Madras Province with a total area of 126,166 sq. miles contains 25 districts including the city of Madras and 222 taluks. Each taluk is further sub-divided into smaller units known as firkas, each firka consisting of 20 to 25 villages. The district is too artificial a unit for economic planning, and the village is too small to be of any practical use in generalisation, hence the need for a unit of intermediary size, on the basis of which major regions should be evolved. According to the Indian Council of Agricultural Research, the Madras Province includes three regions—Rice region, Millet region and Malabar region. The Industrial Planning Committee constituted by the Government of Madras suggested six regions on the basis of the present districts, the boundaries of which, in most cases cut across the geo-economic trends. Both the above regional schemes are uni-regional, and Madras Province is an agro-industrial and forest province, and for successful regional planning, regional schemes must be based on composite regional factors. According to the regional concept, and on the basis of composite planning factors, the Madras Province is tentatively divided into : (1) the southwest coast plantation cum rice zone, (2) the east coast agro-forest zone, (3) a part of the Tinnevally-Mysore agro-industrial complex and (4) a small portion of the central Deccan Plateau where the occupancy pattern is still evolving.

38. Geo-climatic Aspect of the District of Allahabad.

Mohd. Naseer Khan, Allahabad.

Climatic conditions are generally dealt with on regional basis, and very often cover large areas. This paper has been written from the point of view of understanding local climatic conditions of a given small area.

The paper deals with the climatic aspect from the geographical point of view of Allahabad District which is located on about the confluence of the rivers Ganga and Yamuna. The district covers, 2,848 sq. miles and comprises of eight tahseels namely, Chail, Handia, Mahjhanpur, Meja, Phulpur, Sirathu, Soraon and Karchana.

After a bried introduction of climatic factors, temperature conditions, rainfall, and the variability of rainfall are dealt with. Climatic divisions are introcued. Finally the effect of climatic conditions on economic activities are shown.

39. Some Factors in the Development of Pakistan : A Geographical Consideration.

Maneck B. Pithawalla, Karachi.

Pakistan has inherited a number of physical disabilities, which may be classified as (1) *Geological* : the rocks are very young, highly folded in the mountainous regions, and nearly 99% Sedimentaries. As a result they are unstable, lacking in metalliferous ores etc. ; denudation is enormous, and the rivers young and changeable and quickly silted up at their mouths. (2) *Physiographic* : The desert is advancing northwards, waterlogging and Kalar soils are formed with intensive cultivation, growing deltas afford few chances of harbours, and the fluctuation of water resources causes planning difficulties. (3) *Climatic* : The monsoon rains are late, irregular and scanty in West Pakistan and excessive in East Pakistan. (4) *Spacial* : The two Pakistans are some 1000 miles apart, and Eastern Pakistan is merely an enclave. The two chief harbours are 1000 miles distant from each other. (5) *Industrial* : Antique methods are used everywhere, no iron and steel works are possible, and power resources especially coal and petroleum are limited.

To balance the economy of Pakistan requires intensive regional and land utilisation surveys, which needs a large band of geographers. Unfortunately, the science of Geography, so powerfully nation-building and fruitful, is not sufficiently practised or appreciated.

40. Selection of a Site for the New Capital of Sind.

Maneck B. Pithawalla, Karachi.

Sind, having lost its flourishing capital of Karachi to the new Dominion of Pakistan, must needs have another suitable site for its new metropolis in some other part of the province. For this purpose the Government of Sind have appointed a Site Selecting Committee, who, it has been reported, have recommended a spot falling within the triangle of Jungshai, Jhimpir and the Makli hills, suggesting that its climate is good and all the amenities of life will be found there. This proposal has been criticised in this Paper from the point of view of Geography and as the alternative, the old city of Hyderabad has been recommended strongly from the following points of view : (1) Topography, (2) Climate, (3) Water supply, (4) Amenities of life, food etc., (5) Future development, and (6) Stability of settlement. From all these points of view, Hyderabad would make a far better capital than any other site in Sind.

For a capital city to command a whole province, there must be some stimuli from agricultural and industrial life of the people. These will be found in abundance at Hyderabad, which also has a good historical and heroic background, against which it can stand for all times.

So near the new Lower Sind Barrage with such high traditions, situated centrally amidst first-rate arable lands with plenty of water supply, with vast areas for expansion on every side and with inland fishery to take the place of marine fish of Karachi, and also commanding the land, river and air routes of Western Pakistan, Hyderabad must be given the fullest possible consideration to be the capital of New Sind. But the great trouble in our country is that such schemes are made off-hand without any proper regional survey, which only trained geographers can make with efficiency. Sind has lost an ideal and up-to-date capital in Karachi and it is hoped that it acquires a site for its new capital as only the second best in the province.

41. Land Utilisation of Prayag Area.

Mohd. Naseer Khan, Allahabad.

Land utilisation is a branch of field geography. It represents a graphic picture of an area in the manner in which it is being utilised by man. The areas which are theatres of human activities such as cultivated lands, grazing grounds, woodlands and built up areas ; and the areas not in use such as waste lands and culturable waste, are shown on maps with appropriate descriptions. The whole outlook gives a graphic picture of the conditions of the region, on which can profitably be based economic planning and reconstruction work. The Land Utilisation survey is carried on in detail by surveying in smaller units and afterwards combining them into a region of considerable size.

Most of the civilised nations are planning for development of their countries on the basis of Lald Utilisation. The whole of Britain has been surveyed by Prof. Stamp and much has been done in U.S.A. in that direction.

For the purpose of Land Utilisation a small area known as "Prayag Area" on the north-west of Prayag Station has been selected. On the eastern side is limited by railway line running from Prayag Station to Phapamau, on the north, west and south bounded by Ganga Kachar. A number of maps have been prepared to show the data collected.

42. Mixed Farming in the Tarai Region.

F. Ahmed, Calcutta.

Whereas the Tarai Region has recently been recognised as a separate natural region, it has come to prominence in connection with the food drive schemes of the U.P. Government. But the possibilities of mixed farming in the area are being ignored and this might adversely affect even the existing cattle breading industry, which meets the requirements of at least three provinces. The present paper deals with the general conditions in the country, the present state of mixed farming in the Tarai Region and pleads for help to develop the industry in the region.

SECTION OF ZOOLOGY AND ENTOMOLOGY

President :—Dr. B. C. Basu, D.Sc.

CYTOLOGY

1. The Synthesis of Desoxyribose Nucleic acid in the developing Macronucleus of Chilodonella uncinatus Ehrbg.

B. R. Seshachar, Bangalore.

Developing exconjugants of *Chilodonella uncinatus* show that the two nuclear anlagen start about the same size of 1.7 uiudiameter, and while one of them grows to become the macronucleus, the other remains as the definitive micronucleus of the animal. The history of the macronuclear anlage falls into two phases.. The first is one of great enlargement culminating in a macronuclear anlage of a colossal size of 17.3 u, in diameter, filling up much of the space in the cell. During this phase of enlargement, the nucleus is very pale and faintly staning. After the maximum size is reached, the anlage shrinks to the size of the adult macronucleus, which is about 6.06 u in diameter, at the same time acquiring the structure characteristic of it. Photometric measurements of the developing macronucleus show that throughout this period of enlargement and diminution, the macronuclear anlage is synthesizing D.N.A and while in the first phase two-thirds of its D.N.A content is acquired, the other one-third is synthesized in its second phase. The view is held that this D.N.A comes from the old macronucleus which show a progressive degeneration corresponding with the growth of the macronuclear anlagen.

2. Role of the Nucleolar Bodies in the growth of the Egg.

Brahma S. Kaushiva, Lucknow.

This investigation deals with the extensive cytological changes that occur in the oocyte during oogenesis.

In the oocyte two kinds of nucleoli are present : plasmosomes and karyosomes. The plasmosomes are non-chromatinic and give a negative Feulgen reaction. The karyosomes, on the other hand possess chromatin material. Methods were not employed which demonstrate the true chemical nature of the nucleolus. The plasmosome undergoes active changes in form, size and staining capacity during oogenesis. In early oocytes it occurs as a single rounded body within the nucleus. On reaching a certain size it begins to fragment and forms several smaller bodies. These bodies arrange themselves near the nuclear membrane and are eventually extruded into the cytoplasm of the oocyte. Likewise karyosomes are extruded, but less frequently. Follicular nuclei and epithelial cells are also emitted into the ooplasm and thus serve as a second source of chromatin material for the ooplasm.

It is suggested that the extruded plasmosomes provide the agency by which ribonucleic acid from the nucleus is laid down into the egg cytoplasm. This conclusion is supported by the observations of Caspersson and Schultz (1940), Brachet (1940) and Painter (1945). The functional significance of the extruded karyosomes is problematical and no suggestion of their role in the cell metabolism is offered here.

3. Studies on chromosome behaviour. I. (Oedipodinae, Acrididae).

M. K. Dutt, Izatnagar.

A detailed quantitative study of meiosis and chiasma formation have been carried out on *Trilophidia turpis* Wlk., *Oedaleus abruptus* Thunb. and *Acrotylus humbertianus* Sauss. In all the three genera studied, the diploid number of chromosome is $2n=23$ in the male. Measurement of chromosomes at 2nd. division metaphase stage shows that there are a pair of long chromosomes in both *Trilophidia* and *Acrotylus*. The number of the small chromosomes differ in the three genera. The X -chromosome is one of the medium sized ones in all the three. The chiasma frequency for the whole nuclei at diplotene, diakinesis and metaphase is 13·93+0·28, 13·26+0·30 and 12·80+0·36 in *Trilophidia*, 14·72±0·34, 13·80±0·12 and 14·00±0.27 in *Oedaleus* and 15.85±0.80, 14.84±0.32 and 13.88±0·23 in *Acrotylus* respectively. There is a statistically significant reduction of chiasma frequency from diplotene to metaphase in both *Trilophidia* and *Acrotylus*. Significant increase in teminalisation coeflcient has been observed in *Trilophidia* only. The longest bivalent of *Oedaleus* shows in most of the nuclei a very prominent terminal heterochromatic segment. Polyploidy both at spermatogonial metaphase and spermatocytes has been observed in *Oedaleus*.

4. Studies on the Chromosome behaviour and sex chromosome in Chrotogonus sp. (Acrididae, Pyrgomorphinae).

M. K. Dutt, Izatnagar

The chromosome number has been found to be $2n=19$ in the male. There are a pair of long, a pair of small and 7 pairs of medium sized chromosomes. The sex chromosome is longest in the complement. The sex chromosome in this species, unlike that in others Acridids studied so far, never shows negative heteropycnosis in either spermatogonial prophase or at any stage of metaphase. It becomes positively heteropycnotic at the prophase of meiosis and continues to be so right upto diakinesis. Occasionally this chromosome exhibits a slightly lesser staining affinity at Metaphase I. Its negative heteropycnosis starts from late anaphase I. It becomes over condensed at Telophase I, and remains so ever after. Thus the heteropycnotic phenomena in *Chrotogonus* take place only during meiosis. The X -chromosome is reductional in the first meiotic division.

The average chiasma frequency for the whole nuclei at diplotene, diakinesis and metaphase are 11·97±0·28, 11·44±0·25 and 11·44±0·21 respectively. A detailed study of the movement of chiasmata shows that there is no loss of chiasmata in the long bivalents. A slight loss of chiasmata and an appreciable increase in the terminal chiasmata have been observed in the medium sized ones from diplotene to diakinesis. The short bivalents show almost no movement.

5. Spermatogenesis in Crocidura Caerulea (Anderson).

G. W. Vaidya, Nagpur.

The spermatogonium is a small, rounded cell with compact Golgi elements on one side. The mitochondria are dispersed in the cytoplasm near the Golgi mass. The primary spermatocyte contains Golgi elements in the form of distinct granules localised in the resting cell but scattered just prior to division. The mitochondria are in a dispersed state throughout. In the secondary, spermatocyte the Golgi elements aggregate to form a mass near, but not touching the nucleus. In the spermatid this mass is very conspicuous lying on the nuclear wall. This Golgi mass gets transformed into a big, fan shaped acrosome. The nucleus of the spermatid is very small and stains homogeneously by Feulgen reaction. The mature sperm has a very conspicuous, heart-shaped, thin acrosome about ten times bigger than the head which is inserted in its posterior side. There is no post-nuclear cup or insertion notch. The neck region is very much reduced. The middle piece is short and merges in the tail of moderate length.

6. A case of non-division of the sex chromosomes in both meiotic divisions of the bug, Dysdercus koenigii (Fabr.).

S. P. Ray Chaudhuri *and* G. K. Manna, Calcutta.

The sex chromosomes divide either at the first or second meiotic division and consequently one of these divisions becomes either equational or reductional for the differential segment of the sex chromosome. A curious case of non-division of the X and Y chromosomes at both meiotic divisions has been discovered in *D. koenigii*, a hemipteran belonging to the family Pyrrhocoridae.

The diploid number of chromosomes was determined from the spermatogonial metaphase stage and was found to be 16. A study of the meiotic divisions revealed that the species has an XY—mechanism of sex determination. The sex-chromosome pair pass to the opposite poles at anaphase. I. Curiously enough, in the anaphase stage of the second meiotic division either the X or the Y (as the case may be) again travel undivided to one pole of the spindle thus giving rise to sperms, half of which receives a sex chromosome and the other half is without it. The latter kind is probably entirely non functional because examinations of the chromosomes of the testes of a large number of individuals always revealed a constant number of chromosomes. The division of the sex chromosomes is presumably postponed till the first cleavage division of the zygote.

7. X and "Neo-Y" mechanism of sex determination in an Indian Grasshopper.

S. P. Ray Chaudhuri *and* A. Guha, Calcutta.

The spermatogonial metaphase complement of Eupreprocnemissp is 22 with an X and "neo-Y" mechanism of sex determination. This mechanism has evolved from an XO type by a single translocation between a member of one of the longest pair of autosome and the original heterochromatic X chromosome. The reconstructed X, therefore, has a short heterochromatic and a comparatively longer euchromatic segment. During the first meiotic division the homologous member of the autosome pair involved in the translocation acts as a mate to the translocated arms of the X by forming a terminal chiasma and thus in effect becomes a Y chromosome.

The evolution of X and "neo-Y" in the present case, must be of very great antiquity because unlike the translocated segment of the X, the Y has become heteropycnotic by being confirmed in the male line for a long period. The original X and also the Y remains over condensed throughout the prophase of meioisis but the nature of condensation is different in the two cases indicating distinct origins for the two types of heteropycnosis. The short terminal pairing segment of the X also appears to be heteropycnotic like the Y.

8. Effect of X-rays on the meiotic chromosomes of Gesonia punctifrons (Acrididae).

Ira. Bose, Calcutta.

The effect of ionizing radiations on the mitotic chromosomes of animals and plants are well known, although comparatively few attempts have so far been made to study the same in the meiotic chromosomes. An attempt has therefore been made here to study the diverse effects of X-rays on the meiotic chromosomes of the grasshopper *Gesonia punctifrons* in order to understand more precisely the nature and significance of structural changes produced by irradiation.

Four lots of the male grasshoppers were given 40, 120, 280, and 320 r units of X-rays respectively, keeping every other condition constant. The chromosomes were studied at successive hours after irradiation starting from 6 hours and extending upto 72 hours.

The different types of X-ray induced changes obtained in the metaphase stage of the first division may be classified as (i) Gaps or unstained regions in one of the homolouges of a bivalent; (ii) faint-stained regions; (iii) single chromatid breaks; (iv) single-thread connective between the broken pieces; (v) constrictions; and (vi) faintly stained constrictions.

The changes recorded at Anaphase I of meiosis are inversion bridges with fragments and fragments alone.

All these types of chromosome changes both at anaphase and metaphase of 1st division of meiosis show a definite increase at the higher dosages; but none of these types exhibit a direct proportionality to the increased desages, either at any particular hour after irradiation or as a total of all hours. The frequency of changes at almost all the dosages is highest in chromosomes examined at 72 hours after treatment. The significance of the above results has been discussed.

9. Chromosome behaviour in fourteen species of Hemiptera.

G. K. Manna, Calcutta.

Meiosis in the males of fourteen species of Hemiptera belonging to three different families have been investigated. All the species belonging to the families Pentatomidae and Lygaedae studied, show XY mechanism of sex-determination whereas those belonging to Coreidae show XO type. The sex chromosomes in all the species divide equationally in the first meiotic dividsion and in the second division, the X and the Y pair at metaphase and move to the opposite poles of the spindle. Chromosome counts in the spermatogonial and spermatocyte stages in the various species are shown below :

Name	Spermatogonial count	Primary spermatocyte count	Secondary spermatocyte count
PENTATOMIDAE.			
1. **Coptosoma cribarium** (Fabr.)	12	5,X ,Y	6
2. **Aspongopus obscurus** (Fabr.)	14	6,X ,Y	7
3. **Aspongopus Janus** (Fabr.)	14	6,X ,Y	7
4. **Agonoscelis nubila** (Fabr.)	14	6,X ,Y	7
5. **Halys dentatus** (Fabr.)	14	6,X ,Y	7
6. **Plautia fimbriata** (Fabr.)	14	6,X ,Y	7
7. **Eusarcocoris guttiger** (Thumberg)	14	6,X ,Y	7
LYGAEDAE.			
8. **Lygaeus hospes** (Fabr.)	14	6,X ,Y	7
9. **Lygaeus pandurus** (Scop.)	14	6,X ,Y	7
10. **Graptostethus sevus** (Fabr.)	14	6,X ,Y	7
COREIDAE.			
11. **Leptocorisa acuta** (Thumberg)	17	8X	7
12. **Serinetha augur** (Fabr.)	13	6X	7
13. **Cletus bipunctatus** (Fabr.)	17	8X	9
14. **Cletomorpha hastata** (Fabr.)	21	10X	11

10. Multiple sex-chromosome mechanism in a Reduvid bug, Conorhinus rubrofasciatus (de geer).

G. K. Manna, Calcutta.

A number of cases of multiple ses-determining mechanism in the Hemiptera have been reported from the family Reduvidae. Among the several species of male Reduvid bugs examined by the present author *Conorhinus rubrofasciatus* shows X_1 X_2 : Y type of sex determination. The sex chromosomes divide equationally at the first meiotic division and form a group of three at the second meiotic metaphase of which the two smaller elements presumably the two X_1X_2 pass to one pole and the large one or the Y to another pole. The chromosome number determined from the spermatogonial metaphase stage is 25.

11. Distribution of Glycogen and Iron in the Placenta of Crocidura caerulea (Anderson).

N. Owers, Nagpur.

It is only recently that studies have been undertaken to investigate the cytochemistry of the gravid uterus. During the development of the embryo various structures, e.g., uterine glands, uterine epithelium, yolksac, chorioallantoic placenta, become successively inportant as media for physiological exchange between mother and foetus. The author has studied the distribution of glycogen and iron in the uterus of *Crocidura caerulea* (Insectivora) during different stages of gestation. This animal was chosen for study because its embryology is well known. (Sansom, 1937). The author also discusses the techniques used for micro-chemical tests.

12. Alkaline phosphatase in the uropygial gland of normal and of androgen treated pigeons.

Amiya B. Kar, Calcutta.

Alkaline phosphatase is present in diffuse quantities in the uropygial gland of the pigeon. Androgenic treatments depress the activity of the enzyme in the gland but do not abolish it. It is suggested that the holocrine lipoidal cycle in this gland is mediated by the phosphatase through the influence of sex hormones. The possible role of the phosphatases in the mechanism of action of hormones is discussed.

EMBRYOLOGY

13. Stages in the Development of Tornaria Krohnii from Madras.

K. Pampapathi Rao, Madras.

Ramunni Menon recorded this larva in 1903 and Stiasny-Wijuhoff and Stiasny classified it as Tornaria Krohnii and attributed it to Glossobalanus.

Material was obtained from the plankton. The larvae were reared in finger-bowls for nearly a month. Three important stages, covering the development upto the metamorphosis were described—namely, the Muller stage, the Krohn stage and the metamorphosed larva.

The Muller stage is the youngest and smallest. The apical plate, apical tuft and the apical string are present. The longitudinal bands are very simple. The telotroch is absent. The alimentary tract is well developed, and the proboscis coelom is formed.

The Krohn stage represents the highest development of the free-swimming larva. All the ciliated bands are well formed. The coelomic pouches are all formed. The larva swims freely at the surface.

The metamorphosis takes place after the larva took to the bottom and decreased greatly in size. The youngest metamorphosed form has a well-defined proboscis with the central complex just pushing forward. The collar is also differentiated though not quite clear. The telotroch, the apica tuft and the eyespots still persist. The larva is more opaque and begins burrowing.

Thus there is a progressive, a regressive and a metamorphosis period in the growth of the Tornaria of Madras as noted by Stiasny in other forms.

14. On the development of the vertebral column in Rana tigrina, and its position in the phylogenetic history of the centrum of Salientia.

H. K. Mukherjee *and* J. N. Rudra, Calcutta.

The formation of the centrum from the perichordal tube has been clearly shown by Mukherjee and his collaborators, in several species of Salientia. It has been shown that the centrum develops from the perichordal tube, or part of it and from the arch bases, as stated by previous investigators. The presence of a median ventral cartilaginous *hypochord* in different regions of the vertebral column has been described by some workers in some Salientia. Mukherjee and his co-workers have shown that the mid-ventral hyaline cartilaginous structure is a part of the perichordal tube and may be present in varying extent in different groups of Salientia.

The present paper deals with the development of the vertebral column in *Rana tigrina*—the common bull frog of India. The notochord shows a moniliform appearance in the present case, which has also been observed in other speciments of Salientia so for examined. This moniliformity appears to be a typical feature of the notochord in Salientia. The ventral hyline hypochordal element is present only in the region of the urostyle and a little in front of it. This presents an intermediate condition between *R. Temporaria and B. melanostictus*, where the hypochordal element is totally absent, and *R. afghana*, where it is present from the third vertebra to the tip of the urostyle. A probable explanation, by way of suggestion, has been given about the function of this hypochordal element. A short review of the different opinions about the mode of formation of the centrum in Salientia has also been given.

15. Embryology of Cynopterus sphinx gangeticus.

M. A. Moghe, Nagpur.

Except for a very fragmentary account of the embryology of *Cynopterus marginatus* by Keibel (1922), very little is known of the embryology of this megachiroptera. The author has examined a very complete series of gravid uteri and specimens at parturition.

Fertilisation occurs in October. All specimens collected on any one day do not show the same stage of pregnancy. It is probable that amniogenesis takes place by cavitation and by folding. The plecenta is labyrinthine, discoidal, mesometrial and hemochorial. The general features of the foetal membrances in this animal are discussed and compared with *Pteropus* and the microchiroptera. Parturition occurs in January. It is possible that there is more than one breeding season though not for the same individual.

16. Placentation in Lyroderma lyra lyra (Geoffroy)—Megadermatidae.

A. Gopalakrishna, Nagpur.

No work has so far been done on the foetal membranes of any member of the family Megadermatidae. *Lyroderma lyra lyra* is a common species of insectivorous bats found in India. The present paper embodies the description of a late stage of development. The arrangement of the foetal membranes in this species resembles that of most other species of insectivorous bats so far studied. The chorioallantoic placenta is discoidal, antimesometrial and haemochorial. The uterus is bicornuate, but only one horn bears pregnancy. At the present state of knowledge of the embryology of this family it is not possible to comment on the statements of Wood Jones (1917) and Harrison Matthews (1937 & 1942) if the left part of the genitalia degenerates in this species also as happens in many species of microchiroptera.

17. On the Origin and Fate of the Pallial Layer in the Oocytes of Marine Teleosts.

H. S. Chaudhry, Allahabad.

In this paper attempt is made to elucidate the complete history of an interesting cytological structure—the pallial layer—in the ooplasm of some marine Teleostean fishes. This structure though reported by Scharff (1887), Calderwood (1892), Franz (1909) and Dragoiu (1922) in the piscine eggs, but very vague and conflicting accounts are given regarding its origin and fate. Whereas, there are some workers like Wheeler (1924) who regard it as a mere artefact.

It has been clearly shown in this paper that the pallial layer is not an artefact but a definite cytoplasmic structure, at least in some fishes. It is present as a deeply stained granular zone round the nucleus and is formed from the archoplasmic material differenciated by the yolk-nucleus of Balbiani. From the perinuclear position it travels as a complete ring towards the egg periphery, where it gets disintegrated and finally lost in the cytoplasm. The fatty and the proteid yolk spherules are formed by the direct transformation of the Golgi and the mitochondrial granules respectively in the pallial substance. The pallial substance does not show any direct relationship either with the chromatin material of the nucleus or the yolk spherules.

18. The Development of the Trunk Vertebra in *Ptyas mucosus* (Linn.)

Maheshwar Singh Sood, Agra.

The author has studied several stages of the development of the trunk vertebra in *Ptyas mucosus* (Linn.) in serial sections. The absence of the supradorsal, the composition of the cartilaginous vertebra out of only three kinds of elements (perichordal tube, basidorsals and the cartilaginous ribs) and the absence of connective-tissue arches are amongst the more important features discovered. The formation of the post-and pre-zygapophyses has been investigated.

19. On the Development of the Freshwater Grey Mulle Mugil Corsula (Hamilton)

B. Pakrasi *and* K. H. Alikunhi.

Very little is known about the breeding habits and development of mullets. The accounts of Raffaele (1888), Sanzo (1930) Wimpenny and Fouzi (1936) etc., have not materially helped in giving any specific description of the mullet egg and its nature. The embryonic, larval and post-larval development of the freshwater grey mullet, *Mugil corsula* (Hamilton), have been worked out from eggs and larvae collected from nature by the present authors.

The fertilised egg is demersal, spherical, 0·96 mm. in diameter and with a very narrow vitelline space. A conspicuous oil globule, more than half the diameter of the egg, is the most characteristic feature of the egg. The period of incubation is about 15 to 18 hours. The hatchling, about 3 mm. long, has large transparent eye, a yolk-sac with a large oil globule and several chromatophores on the body. The anal opening is indicated relatively anteriorly, unlike in carp hatchlings.

The mouth and pectoral fin rudiments are indicated in the larva when 40 hours old. With the gradual absorption of yolk the oil globule assumes an anterior position. The eyes get pigmented when the larva is about 3·5 mm. long. The yolk sac is almost completely absorbed in the larva 4.7 mm. long ; the anus is situated against the 10th. or 11th. myotome and is in the anterior half of the body. A large stellate chromatophore appears medially at the nape (4.68 mm. larva), where a concentration of chromatophores later results in a specific pattern ; several chromatophores appear along the mid-ventral line, against the level of the anal fin, along the lateral line and mid-dorsally, and these, to the naked eye, appear later as dark patches in fresh specimens and are characteristic of the larvae as they swim about. The tip of the notochord is straight but get upturned when the larva is about 4.7 mm. long. The second dorsal and anal fins are differentiated early (5.9 mm. larva). The first dorsal gets well marked out only later when the larva is about 6.5 mm. long. The caudal then appears truncate ; and distinct rays are found in the second dorsal and anal. When the larva is 7.65 to 8.0 mm. long, rays appear in the first dorsal and the ventrals. At the 9.63 mm. stage all the fins are found to have their adult complement of rays. The final post-larva stage is about 18.5 mm. long and in that the characteristic straight dorsal profile and the raised eyes of the adult begin to be indicated.

GENETICS

20. Hereditary congenital Flexed Fetlocks in Indian Cattle.

S. V. Chandiramani, *and* P. Bhattacharya, Izatnagar.

Two calves were born with a defective condition of the fetlock joints in the Hariana herd at the Indian Veterinary Research Institute, Izatnagar, and one in the Gir herd of the Indian Dairy Research Institute, Bangalore. The defect was manifested by a sharp and complete flexture at the distal end of the metacarpal bones. The dewclaws were presented in the normal manner, yet sufficiently yielding in position to permit the first phalanx flex right back, making an angle of about 90° with the back line of the metacarpal bone. The abnormal condition was expressed in both the legs. The defect acted as a sublethal, all the calves dying within 40 days from birth. Study of the pedigree records of the affected animals suggested the autosomal recessive nature of the character.

PROTOZOA

21. Encrusting Foraminifera of Krusadai Island.

Cyril Daniel, Madras.

Though *Encrusting foraminifera* have been described before, their occurrence in Indian waters is recorded for the first time. Six species of these, *Planorbulina larvata*, *Gypsina rubra*, *Gypsina plana*, *Gypsina vesicularis*, *Acervulina inharens* and *Homotrema rubrum* are briefly described with notes on their ecology and taxonomic position. The importance of the *Encrusting foraminifera* in the building of coral rocks is discussed.

22. On a Species of Babesia in an Indian Wild Cat.

S. V. Mudaliar, G. R. Achary *and* V. S. Alwar, Madras.

A case of Babesia infection in a wild cat was recorded by the authors for the first time in Madras in 1946. An opportunity was taken to study the organisms, as records of Piroplasmosis in cats are extremely few.

The infection was not heavy and the animal was not showing any symptoms of Babesiosis. The parasites were mostly pear-shaped and a few amoeboid, oval, rounded and band forms were seen, measuring 0·5 u. to 2·5u Two, four and eight parasites as in *B. canis* were seen in the erythrocytes. Neither cross-forms nor evidences of multiplication in a cruciform manner were noticed. Blood inoculation into a domestic kitten failed to produce the infection. A few ticks of *Haemophysalis sp.* were found on the body of the wild cat.

The organisms closely resemble those described by Mangrulkar (1937) the only difference being that he did not record the occurance of eight parasites in a single cell and differs from the description of others, particularly in the absence of cross-forms. Since the morphological characters bear a close resemblance to the genus Babesia and as it is considered as a new species the authors propose to give a new name for this species.

23. Fowl Malaria.

S. B. V. Rao, J. Das *and* D. R. Ramnani, Izatnagar.

Occurrence of natural cases of *Plasmodium gallinaceum* in exotic fowls has been recorded for the first time in this country at Izatnagar Poultry Farm.

24. Myxosporidian Parasites of Indian Carps, Catla Catla (Ham) Labeo Rohita (Ham), Cirrhina Mrigala (Ham), Labeo Bata (Ham), and its Seasonal Variation.

S. P. Basu, Calcutta.

A study of the occurrance of external myxosperidian parasites in the Indian carps were carried out.

318 *Catla catla*, (16-51 cm.), 320 *Labeo rohita* (14.5-35 cm.), 339 *Cirrhina mrigala* (14-34 cm.) and 66 *Labeo bata* (18-25 cm.) were examined from July 1947 to June 1948 in a number of fisheries for external myxoporidian parasites and its seasonal variation in the attack was noted.

Summer—*Catla catla*—nil, *Labeo rohita*—70%, *Cirrhina mrigala*—40% and *Labeo bata* —Nil.

Monsoon—All the fish free from infection.

Winter—*Catla catla*—80%, *Labeo rohita*—nil, *Cirrhina mrigala*—20% and *Labeo bata* —nil.

The parasites examined are *Thellohenellus rohitae* (Southwell and Prashad), *Myxobolous catlae* (Chakravarty), *Thellohenellus catlae* (Chakravarty and Basu), *Myxobolous bengalensis* (Chakravarty and Basu) *Myxobolus mrigalae* (Chakravarty).

Chemical examination, temperature and plankton contents of waters carried out to correlate the occurrence of parasite. The results indicate that occurrance of parasite in waters having 400 p.p.m. of chloride content is negligible and below this there is occurrance of the parasite. Mortality of the fishes due to parasitism is rare except in high infection. Infected fishes become sickly and loss in weight as compared to the normal one. It is possible that presence of cysts in the gill filaments hamper with respiratory metabolism of the fish.

HELMINTHOLOGY

25. A unique digenetic trematode referable to a new family.

H. D. Srivastava, Izatnagar.

In digenetic trematodes the acetabulum when present is situated either at or near the posterior end of the body as in amphistomes or it lies in front of it. Where the acetabulum is situated markedly in front of the hinder end, and such forms are by far the more common, some organs connected with reproduction such as gonads, vitellaria, uterus or organs associated with fertilization, invariably lie wholly or partially in the post-acetabular part of the body. In the course of his investigations on the trematodes of Indian food-fishes, the author discovered a form parasitic in a marine host at Karachi which is remarkably different from all known trematodes. The most remarkable feature of this fluke is that though the acetabulum is situated close behind the middle of the body length all organs connected with reproduction lie in front of it. The presence of long tubular and intricately coiled vitellaria and the opening of the intestinal caeca into the sides of the excretory bladder are also rather unusual characters, though present in some phylogenetically unrelated trematodes. In several important features this trematode differs so remarkably from the hitherto known forms that it is necessary to creat a new family for it with the following diagnosis :—

Medium sized, 10×4.5 mm., muscular distomes with smooth cuticle and well developed suckers, the acetabulum larger than oral sucker and situated close behind the middle of body length ; alimentary system well developed, pharynx prominent, prepharynx and oesophagus inconspicuous, intestinal caeca extending to the hinder end and opening through narrow tubes into the sides of the excretory bladder ; reproductive organs are all situated in the preacetabular part of body, the genital pore at the base of the pharynx, testes—two situated a short distance behind the intestinal bifurcation one on each side of the median line, ovary situated close in front of the aceta bulum to one side of median line, vitellaria in several long irregularly coiled tubes extending from a little behind the genital pore to the anterior level of acetabulum, uterus well developed, preacetabular irregularly coiled containing numerous eggs. Excretory pore subterminal at hinder end of body. Parasitic in the gut of fishes.

26. Two new trematodes from Indian tortoises.

H. D. Srivastava *and* S. B. Manshani, Izatnagar.

In this paper are described one species each of the genera Styphlodora Looss, 1899, and Kaurma Chatterji, 1936, parasitic in the intestine of tortoises at Bareilly. The former genus belongs to the family Plagiorchiidae Luhe, 1901, and is represented by sixteen closely related species occuring in markedly different habitats in various species of reptilian hosts, in widely separated areas of the world. In its systematic position the new parasite stands nearest to *S. compactum* but differs from it in the shape and size of body, position of the acetabulum and gonads, shape, size and position of the cirrus sac and the presence of a long oesophagus, besides the habitat and species of hosts. The genus Kaurma is parasitic in the intestine of Chelonians. The type species—*K. longicirra* was described from Rangoon in 1936 and assigned to the family Allocreadiidae. subsequently, a second species—*K. orientalis*—was described from Japan. The Indian species differs from both these species principally in the size of the body and the position of the cirrus sac.

27. Two new trematodes parasitic in Indian marine food-fishes.

H. D. Srivastava, Izatnagar.

The paper deals with the morphology and systematic positions of two trematodes, one referable to a new genus of the family Allocreadiidae Stossich, 1904, and the other to a new pecies of the genus Pleorchis, family Pleorchiidae Poche, 1925. The allorea-did fluke is ovoid in shape and is very small. The body is devoid of spines but cuticular gland cells are well developed. Oral sucker is slightly smaller than the acetabulum which is situated about the middle of the body length. The oesophagus is absent, pharynx is present and the intestinal caeca extend upto the posterior end. The testes consist of a large number of small follicles aggregated together mostly in the intercaecal space at the posterior end. The cirrus sac contains vesicula seminalis interna, pars prostatica, ductus ejaculatorius and a cirrus ; the vesicula seminalis externa extends upto the anterior reaches of the testes. Ovary is spherical and pretesticular. Uterus is confined to the space between the acetabulum and testes. Genital pore is situated at the level of the middle of the acetabulum, halfway between it and the left body wall. Vitellaria comprises of small follicles extending along the intestinal caeca from the level of the intestinal bifurcation to posterior end where they are contiguous. The characteristic features of the genus are the follicular testes and the position of cirrus sac and genital pore. The species of Pleorchis described has been compared with the three previously known species and a key to the species is given.

28. Studies on some new Diplostome Trematodes of the sub-sub-family *Crassiphialini* Dubois, 1936.

P. N. Chatterji, Cuttack.

Large number of Diplostome parasites were collected from the small intestine of King-fisher *Halcyon smyrnensis fusca*. Most of these trematodes on examination revealed to be of *Crassiphiala* species while some on closer examination were found to be species of *Uvilifer* Yamaguti, 1934 and *Allodiplostomum* Yamaguti, 1935.

Of the two new species described in this paper one comes under the genus Uvilifer Yamaguti, 1934 and another under the genus *Allodiplostomum* Yamaguti, 1935.

A short history of the genera *Uvilifer* Yamaguti, 1934 and *Allodiplostomum* Yamaguti, 1935 and their systematic relation with the genus *Crassiphiala* Van Haitsma, 1925 is given in this paper.

A Key to the genera of the sub-sub-family *Crassiphialini* Dubois, 1936 is also given in this paper.

29. *Vesperugidendrium indicum* (Trematoda) from a microchiroptera.

P. G. Deo, Izatnagar.

A single specimen of the species *Vesperugidendrium indicum*, Pande (1937) was collected from a microchiropteran bat. A detailed study of the stained specimen revealed the undermentioned differences from the form described by Pande.

(1) The oesophagus is short and straight, and not long and curved on one side.

2. The testes are in horizontal plane in the specimen described here while they are diagonal in the specimen collected by Pande.

As only a single specimen was available both to Pande (1937) and the author (1948), it is desirable to refer them to the same species despite some differences in their descriptions and to amend the diagnosis of the genus.

30. On the occurrence of the fluke Clinostomum (Leidy) in the feather-back Notopterus notopterus (Pallas).

P. I. Chacko *and* M. J. Mathews, Madras.

Clinostomum (Leidy, 1856) which occurs in the buccal cavity, pharynx and oesophagus of aquatic birds like heron, bittern, cormorant, and herring-gull, was recorded by us in two specimens of the fish *Notopterus notopterus* captured from the Tunga bhadra project area. The parasites were immature and were found imbedded in small swellings, about 1 cm. in diameter, over the body of the fish, particularly at the base of the fins. The bionomics of the host is briefly recounted.

31. On a Morphological study of the genital organs in certain members of the family Hymenolepididae Fuhrmann 1907.

L. N. Johri, Delhi.

Various genera under the family *Hymenolepididae* are well known for the constancy in the number of the testes contained in each proglottis of a strobila. Interesting variations in the number and positions of the testes are observed in relation to the female genital organs. Further increase in the number of testes is also met with. Testes also show decrease in their number to their atrophy resulting in their final disappearance. Two tables are incorporated to show the arrangement of the genital organs clearly indicating increase and decrease in their number together with their positions.

32. On a collection of Cestodes from Terai Forest—U.P.

L. N. Johri, Delhi.

Notopentorchis hindia n. sp. is obtained from *Dichoceros bicornis* from Terai forest area of U.P.

Specific Diagnosis :—The worm measures 32 mm. in length. The scolex globular bearing double crown of 22-24 hooks measuring, 14-16 u and 20-22 u long. Genital pores irregularly alternating. Genital ducts ventral to longitudinal excretory vessels. Testes 5, lateral and slightly posterior to ovary. Cirrus sac 118-136 u long crossing ventral longitudinal excretory canal. Ovary at centre of proglottis extending towards posterior margin of segment. Uterus a single sac containing egg-capsules. Egg-capsules bearing eggs singly. Eggs and onchosphere measure 22-25 u and 17-20 u respectively. Embryonic hooks 11-13 u long. Uterus sac anteriorly possesses paruterine organ, long, narrow with wavy margins and covered with prominent transverse fibrous markings.

Associated with the new form, some other worms (cestodes) are also found which are not fully developed.

33. Studies on the life history the fowl tapeworm Choanotaenia infundibulum (Block).

S. C. Dutt *and* P. K. Sinha, Izatnagar.

Uptil now 9 species of beetles, 2 species of grasshoppers and the house fly *Musca domestica* have been incriminated as intermediate hosts of *Choanotaenia infundibulum*. Horsfall and Jones (1937) in America studied the development of the cestode larvae in beetles and grasshoppers. The present paper gives a more detailed account of the life history of the parasite and records new intermediate hosts. Details of development in the definitive host have also been studied.

Beetles (16 species), grasshoppers (15 species) and grouse locusts (3 species) were found to act as experimental intermediate hosts of the tape worm. Natural infection was obtained from 2 species of beetles.

At 90°F. to 100°F. temparature mature cysticercoids were obtained from experimentally infected intermediate hosts in 5 days. "Solid-ball" and "hollow ball" stages were found 6 to 40 and 42 to 64 hours respectively after infection. "Tail" was differentiated at about 68 hours. Definite connection between tail and cyst was demonstrated. Connection was generally severed during invagination of scolex but in a few cases was maintained all-through. Tail is deeply stained in methylene blue.

Chickens have been infected by feeding cysticercoids from naturally and expermentally infected intermediate hosts.

Studies on the development in definitive host (chicks) at different intervals after infection, revealed that the parasite settles in the anterior portion of the jejunum by 24 hours and attains maturity as early as 8 days but gravid proglottids are not shed earlier than 14 days after infection.

34. Studies on the life-history and Biology of the Fowl Castode Raillietina cesticillus (Molin)..

S. C. Dutt, P. K. Sinha *and* K. N. Mehra, Izatnagar.

The paper deals with the details of development of *Raillietina cesticillus* in intermediate hosts. Some aspects of biology of the tapeworm in the definitive host have also been studied. Natural (4 species) and expeimental (10 species) intermediate hosts (beetles) of the tapeworm in India are recorded for th· first time. The experimental hosts include *Cincindela sp.* of the family Cincindelidae, which is newly introduced as intermediary. Studies on seasonal incidence of cysticercoids in naturally infected beetles (1 species) revealed an average infection of 5.6%. The incidence was high during November to February.

In experimental infection of beetles and also their larvae mature cysticercoids were obtained in 30 days during January; 26 days during February-March, 16 days during March-April and 12 days in May. Onchospheres were seen entering the body cavity of beetles through the enteric caeca of the midgut. The 'tail' was found to be detached during invagination of scolex, but persisted in the body-cavity of beetles as long as the cysticercoids. The structure described as excretory vessicle by Wetzel (1934) has been shown to be the remnant of the channel connecting the cysticercoid and tail. The larvae of the parasite were not affected by the metamorphosis of the beetle larvae. Imparting infection over a long period, all the developmental stages of the cysticercoid were found to be present in the same host at one time showing the absence of any acquired immunity.

Experimental proof of the factor responsible for the periodicity of daily segment discharge of *R. cesticillus* in the definitive host has been furnished. The period was shifted by changing the hour of feeding of the host. Effects of starvation on segment production have been studied. Date of segment counts have also been presented.

35. Studies on the life history of Hymenolepis carioca, a cestode of poultry.

K. N. Mehra, Izatnagar.

Tapeworms of poultry constitute one of the major factors responsible for retarded growth, lowered resistance and reduced productivity of birds. A detailed knowledge of the life histories of these parasties is essentail for formulating rational control measures against them. With this object in view the life hostory of *H. carioca* was investigated. Large numbers of various types of arthropods were collected from the Institute Poultry Farm, where the infection was known to exist. They were dissected and examined for tapeworm larvae. One type of beetles, some of which have been sent for identification, was found to harbour fully developed cysticercoids which on being fed to one-day-old clean chicks developed into adult specimens of the parasite in a month's time. The number of cysticercoids obtained from a single beetle varied from 10 to 201. Different developmental larval stages from the onchosphere to the cysticercoids obtained from beetles have been studied. Fifty per cent of the beetles collected from the Farm were found to be infected with the larval stages of the tapeworm.

36. A study in the incidence of intestinal Helminths in Poultry at Izatnagar.

S. C. Dutt, Izatnagar.

During June, 1948, to March, 1949, 63 of the fowls that had died in the Poultry farms of the Indian Veterinary Research Institute were examined for intestinal helminths. 71% were found to be infected with one or more species. 56% harboured *Ascaridia galli* and 44% had *Heterakis gallinae* infection. 22% were infected with *Raillientina tetragona* and *R. echinobothrida* were found in 11%. Hymenolepis cantaniana were present in 5% and *R. cesticillus* and *Hymenolepis carioca* were found in 2% of the birds. 17% of the birds were infected with 1 species, 40% with 2 species; 11% with 3 species and 3% with 4 species. The number of worms were : *A. galli* 1-119, H. gallinae 1-250, *R. tetragona* 1-8, *R. echinobothrida* 2-8, *H. cantaniana* 200-1140, *R. cesticillus* 40 and *H. carioca* 140.

Choanotaenia infundibulum infections though prevalent in the farms were not encounted in the dead birds. *Amoebotaenia sphenoides* infection was found in a fowl sent from a neighbouring place (Kiccha). The occurrence of *Hymnolepis carioca* has not been previously reported from any part of India.

37. Studies on the life-hietory of Trichuris ovis.

P. G. Deo, Izatnagar.

In one of the previous experiments on the life-history of *Trichuris ovis* an artificially infected lamb revealed the presence of 689 immature worms from the stomach and small intestine, 48 days after the infection. In the other experiment, one of the artificially infected kid revealed the presence of 362 worms in the small intestines, 85 worms in the large intestine and 466 worms in the caecum, all being immature, 61 days after infection. The second kid in the same experiment passed an unsegmented egg in the faeces 85 days after the infection. This kid was slaughtered along with the control kid 136 days after the infection and 135 mature worms were recovered from the caecum, the control being negative.

In order to verify the results of the last two experiments, an experiment was conducted and it was found that the kid infected with the infective eggs of *T. ovis* passed an unsegmented egg in the faeces 135 days after the infection. Its post-mortem examination, 161 days after infection, revealed the presence of 99 mature worms of *T. ovis* in the caecum. The mucous membrane of the affected kid was slightly congested, highly striated with numerous folds and zigzag stripes and thickened to a considerable extent, while that of the control kid was normal, thin, not striated and without any congestion.

38. An acanthocephalan parasite—Acanthogyrus acanthogyrus—from a common fresh-water Fish Labeo rohita from Bareilly.

P. G. Deo, Izatnagar.

Several specimens of an acanthocephalan worm, *Acanthogyrus acanthogyrus*, were collected from the intestine of a fresh-water fish *Labeo rohita* in 1946-47. The collection consisted of large and small specimens of the species. The small specimens resembled exactly those collected and described by Thapar (1927) while the arge specimens differed in some of the characters, though the external characters were similar. The following significant differences have been noted from the original description :—

1. The variation in the size of the worms in both the sexes.
2. The variation in the number of rows of spines on the body.
3. Presence of ten hooks in the posterior row of hooks on the proboscis.
4. Presence of vesicula seminalis in males.
5. Variation in the number of prostatic glands.
6. Variation in size of testes.
7. Presence of ovary in the young specimens.

The author is of the opinion that the large specimens described in this paper are the mature specimens of this species while the small specimens representing these collected by Thapar are the immature forms of the same.

ANNULATA

39. The Role of Open and Closed Nephridia in Oligochaete Excretion.

K. N. Bahl, Lucknow.

The "Urine" of two kinds of earthworms, one with open nephridia and the other with closed nephridia, was examined to determine the physico-chemical characters and the chemical composition of each. A comparison of the pH, the depression of freezing point and the chloride and sodium contents indicates that while the closed nephridia are largely concerned with the regulation of the water content of the body, the open nephridia have taken on the additional function of getting rid of wastes.

40. On the limit of segment in the Arhynchobdellid Leeches.

M. L. Bhatia, Delhi.

The body of a leech is divided into hundred or more annuli, while true segments are only 33. Most authorities agree that a typical complete segment includes 5 annuli. In the absence of a spacious body-cavity and in the total absence of septa of the type present in earthworms, the exact limit of a segment has not been finally defined, There exist two views about the limit of a segment. One is supported by Whitman and Gratiolet who regard the nerve ganglion of the ventral nerve chain in the first annulus of the somite, the other view is put forth by Castle and Moore according to which the nerve ganglion is in the centre of each segment.

By the study of external morphology, internal anatomy and embryology of *Hirudo* and *Hirudinaria*, it has been possible to solve the controversy and to settle once for all the exact limit of a segment in leech. Observations go in favour of Whitman and Gratiolet view, to regard a nerve ganglion in the first annulus of a segment.

CRUSTACEA

41. Observations on the movements and locomotion of Daphnia longispina.

N. K. Singh, Agra.

The author has studied the bionomics of the water-flea and made minute observations on the movements of the eye, the thoracic appendages and the abdomen. The jerking movement is not caused, as believed by other authors, by the second antenna, but is initiated by the spined abdomen. The rates of the heart-beat and that of the vibration of the antenna have been calculated ; the food-mechanism has been studied The posterior vibratile hair-like processes attached to the soft mass of tissue below the abdomen are mobile cuticular structures and contrary to what is given in various text books and works of reference cannot be regarded as setae.

42. Sex differences in Pelagic Copepoda.

S. Krishnaswamy, Madras.

The Copepods exhibit a large number of variations in the external form of the two sexes, from a mere difference in size to the most marked differences which led the old writer like Claus to classify the males of some of the species in separate genera. The differences are mainly in size, shape, the number of joints in the abdomen, the modifications of the antennule and the fifth leg. (1) *Size* : The male is smaller than the female. But in *Euterpina acutifrons* the male is more or less of the same size as the female and in *Copilia mirabilis* the male is larger than the female. (2) *Prehensile organs* : The antennule is generally modified for grasping in the male. In forms like *Centropages furcatus* the right antennule is very swollen, hinged, distal part capable of being flexed over the proximal part. In many Calanoida the fifth leg is also prehensile in the male e.g., *Labidocera, Pontella.* In *Harpacticoids* and *Cyclopoids* the modification of the antennule is always bilateral as in *Euterpina acutifrons* and *Oithona rigida.* Informs like *Oncaea, Corycaeus* and *Corissa* the maxilliped is prehensile in the male. (3) *The number of joints in the abdomen* : The abdomen is three jointed in the female and four jointed in the male as in *Mecynocera clausii* or it is two jointed in the female and five jointed in the male as in *Calocalanus pavo* or it is four jointed in the female and five jointed in the male as in *Kelleria rubimaculata.*

43. Breeding-Seasons of the Copepods of the Madras Plankton.

S. Krishnaswamy, Madras.

The evidences of the breeding-seasons, such as the presence of naupli, early copepodites, the occurrence of Copepods in copula are described. The Copepods of the Madras Plakton can be divided into three groups on the basis of their breeding habits. (a) forms that breed through out the year e.g., *Euterpina acutifrrons, Oithona rigida* (b) forms that breed in certain months e.g., *Pseudodiaptomous aurivilli, Macrosetella gracilis* (c) forms that do not show any indication of their breeding in the inshore waters e.g., *Undinula vulgaris.* As observed by Wilson (1932) "each season begins towards the last of the month preceeding and continues into the month following". The breeding activities a re at their peak in July, September, December and March. The breeding of the Copepods is definitely periodic. As suggested by Orton (1910), a correlation of the temperature with breeding seasons shows that breeding takes place when the temperature ranges from 23.5°C. to 26°C.

44. Observations on the development and parental care in the Potomonid Crab, Paratelphusia (Barytelphusia) Jacquemontii (Rathbun).

P. I. Chacko *and* S. Thyagarajan, Madras.

This crab breeds along the rocky margins of the supply channels and Cauvery river in the Mettur dam area, in the month of February, March and April, when the flow and level of water is mild and low. The number of eggs in a sponge varies from 360 to 420. The eggs are spherical, 1.6 to 2.0 mm. in diameter, and orange-coloured. Development is rapid, all the larval stages being atrophied. The young ones, with a form completely resembling the adult, break open the egg shells on the sixteenth day, but remain in the brood-pouch. The parental care lasts for about 22 days, at the end of which pcirod, the young ones, 4 mm in length and 5 mm in width, leave the mother to lead an independent life. Ecology of the breeding area, details of development and parental care are described.

ENTOMOLOGY

45. Effect of Temperature on Toxicity of DDT Films.

S. Pradhan, New Delhi.

A series of exploratory experiments on the relationship between temperature and toxicity of DDT films to adults of *Tribolium castaneum* Hbst. and larvae of *Plutella maculipennis* are described. The main observations with *T. castaneum* are :—

(1) When the insects are continuously kept on the film at different temperatures there is higher kill at higher temperatures.

(2) When the insects are exposed to the film for about 24 hours at the same temperature and then kept away from it at different temperatures there is a higher kill at the lower temperature.

(3) When the insects are kept on the film at different temperatures for about 24 hours and then kept away from the film for reaction at the same temperature, there is higher kill in those kept on the film at higher temperature.

With larvae of *P. maculipennis* the observations Nos. 1 and 2 remain unchanged but No. 3 is reversed. The probable cause of this reversal appears to be the observed fact that at higher temperature these larvae cover the film with much more silk thread and thus avoid the film to a greater extent than at lower temperatures.

The above experiments and a review of literatures indicate that many of the observations made upon the temperature-toxicity relationship can be accounted for by the following generalisations :—

(1) Insect resistance to poisons changes with temperature as do its other vital activities, increasing up to a critical degree and afterwards declining.

(2) The amount of poison reaching the site of action in unit time varies with the temperature, generally but not always increasing with its rise. Insect activity, specially locomotor and respiratory, may play an important part in these effects.

(3) The apparent effects of temperature on insecticidal action is the combination of these two factors, namely, resistance and pick-up.

46. Effect of Relative Humidity on Toxicity of Insecticide Films.

S. Pradhan, New Delhi.

Experiments on the effect of changes in relative humidity on toxicity of DDT and DNC films to adults of *Tribolium castaneum* Hbst. and larvae of *Plutella maculipennis* Curtis are described. With *T. castaneum* adults the toxicity of both DDT and DNC films is increased at higher relative humidities, but with larvae of *P. maculipennis* the toxicity of DDT film decreases while that of DNC film increases at higher humidities. Like these experiments the perusal of literature also does not help to deduce any general principle. However, it is possible to collect instances showing that besides the insect and the insecticide, there may be various factors like the range of humidity tested, the strength of the insecticide used, the stage of the insect, etc., which can affect the observation on effect of humidity changes.

47. Effect of Concentration on Temperature Coefficient of DDT action in insects.

S. Pradhan, New Delhi.

Recently Fan. Cheng and Glenn Richards (1948) reported from Minnesota that following external application, the temperature coefficient of DDT action in insects is a function of DDT concentration or dosage and that it is positive at high concentrations and negative at low concentrations. From these observations they concluded that "at low concentrations DDT penetrates the arthropod cuticle more effectively at low temperatures."

In the present contribution it has been shown that the experimental data published by the above authors do not justify such a fundamentally unexpected conclusion as quoted above and that they satisfactorily fit in the three fundamental generalisations recently reported elsewhere by the present author.

48. Relation between specific susceptibility of insects to HCN and the amounts of HCN recovered after fumigation from different species of insects.

S. Pradhan and S. C. Bhatia, New Delhi.

Insects were fumigated in two lots with several concentrations of HCN, the exposure time being kept constant. From one lot of insects, mortality was studied after 48 hours and from the other lot of insects, HCN was recovered by distillation and estimated by a colourimetric method.

The percentage mortality in different species could be positively correlated (*a*) to the different concentrations of HCN used in fumigation and (*b*) to the amounts of HCN recovered per gram body weight of the corresponding lots of insects after fumigation. There was nothing extraordinary so far as these correlations were studied separately, but the comparative positions of different species in these two correlations appeared to be paradoxical. The same species which appeared to be the least susceptible on the basis of the first correlation (i.e., adult females of *Drosicha sp.*) also appeared to be the most susceptible on the basis of the second correlation.

In order to explain this apparent anomaly the following assumptions have been put forward :—

(*a*) that there is an *apparent resistance* of a species which is shown by plotting the values of the percentage mortality against the concentrations of HCN used in fumigation.

(*b*) that the *apparent resistance* is a function of (*i*) *surface resistance*, i.e., the capacity of the insect to resist the entry of HCN into the insects' system and (*ii*) *internal resistance*, i.e., the capacity of the insect to resist the toxic effects of HCN.

The insects used for the study were (1) 7th instar caterpillars of *Corcyra cephalonica* Staint (Fam. Pyrallidae : Lepidoptera), (2) adults of *Tribolium castaneum* Hbst. (Fam. Tenebrionidae : Coleoptera) and (3) 1st—2nd stage nymphs, (4) 3rd—4th stage nymphs and (5) the adult females of *Drosicha* sp. (Fam. Coccidae : Homoptera).

49. A note on the Insecticidal properties of Annona Squamosa (Linn).

Mohan Babu Naidu and Syed Husain Zaheer, Hyderabad Deccan.

Annona squamosa (Linn) was investigated to determine its insecticidal properties. When tested for contact poison against Aphids, seed extract and expressed oil were equally toxic. The petroleum ether insoluble portion derived from ether extract was slightly more toxic to Aphids than ether soluble extract. As a stomach poison the insecticide was effective even in small concentrations to Saw-fly larvae (Athalia Proxima, K), and to adult Pumpkin Beetles (Aulacophoea foveicollis, K). Encouraging results were not obtained when tested for residual action.

50. Studies on the control of Poultry Lice.

P. B. Menon and C. M. Sen Gupta, Izatnagar.

A series of experiments were conducted to determine the effectiveness of DDT, Derris powder, Sodium Fluoride and mixture of Derris and DDT on poultry lice. Insecticides were used in various proportions.

5% and 2.5% DDT and mixture containing DDT and Derris (2.5% and 5% respectively) were found equally effective both in killing and residual effect. 10% Derris had the similar killing property but was found less effective in residual effect. 33% Sodium Fluoride had practically no residual effect.

51. Certain Aspects of Taxonomy in Insects.

A. P. Kapur, Kashmir.

The functions of taxonomic entomologist can be conveniently divided into the following four categories : (1) Curatorial, (2) Routine determination, (3) Separation of new species including their description and (4) Classification.

The curatorial work is discussed with special reference to the Insect Collection in the Zoological Survey of India and the Indian Museum, and an estimate given of the extent of the collection. The importance of a large collection cannot be over emphasized for taxonomic studies and a plea is made for a further development of this largest National Collection.

Species are naturally composed of 'population units' the members of which are often more homogenous than the different units. The latter are supposed to interbreed although they may be defined by discontineous ecological and topographical conditions. In the vast majority, however, the species stand out as collection of populations in which the resemblances outweigh the differences. Since there is a certain amount of variation in even a 'population unit' it is better to try and determine even a small sample than a single specimen. Apart from giving names to the insects mainly for the benefit of other workers the purpose of identification is also to make certain predictions regarding their habits, etc.

Species are usually separated from one another by a number of characters wihch show various degrees of discontinuity. The different characters are then correlated with one another and the species, new or already known, defined. Not only the morphological characters but the biological ones also are taken into account for this purpose.

A good classification makes possible useful predictions about unfamiliar species. Undoubtedly a classification based on the phylogeny of a group is better than any other. In the absence of fossil evidence the phylogeny of a group is to a certain extent elucidated by such studies as comparative morphology, embryology, geographical distribution, etc. A classification that makes no phylogenetic claim would be of limited use mainly for routine identification.

52. Biology of *Afidenta gradaria* (Mulsant) with Notes on the Identity of other Epilachninae damaging Vegetable Crops in India (Col. Coccinellidae).

A. P. Kapur, Kashmir.

Afidenta gradaria (Mulsant) has been found feeding on various kinds of beans in Calcutta and in Muzaffarpur (Bihar). Although originally described in 1850 from Calcutta and Coromandel, it has not been reported in any subsequent papers on Indian entomology and has apparently been confused with other species of *Epilachna* with which it agrees in the number and pattern of the black markings on the elytre. The species (or its subspecies and varieties) is distributed in Java, Malaya, Indochina and China, and the records on the labels borne by the material from the former two countries show that there also it feeds on bean leaves. The life-history and the feeding habits are described and the means of distinguishing the various stages of this species from those of other common Epilachninae in India are given.

53. Statistical analysis of variability in body-size, etc. of various types of individuals of Desert Locust (Insecta : Orthoptera : (Acrididae).

M. L. Roonwal *and* M. K. Nag, Calcutta.

In continuation of a previous paper (Roonwal, *Rec. Indian Mus,*, vol. 45 pts. 2 & 3, 1947 (1949), pp. 149-165), a rigid statistical analysis was undertaken of the sizes of certain body-parts, *e.g.*, the length of the elytron (E), the hind-femur (F), etc. and the ratios of some of these, *e.g.*, E/F, etc. belonging to some important types of indivuduals of the Desert Locust, *Schistocerca gregaria* (Forskal), *viz.*, phase *gergaria* 6-eye-striped, phase *solitaria* 6-eye-striped and phase *solitaria* 7-eye--striped, the last two being of the blue-grey type. 'Fawn'-type *solitaria* forms were also studied, from a very small number of observations. Means, standard deviations and coefficients of variation with corresponding standard errors for each character were calculated and the significance of the differences in mean values among various types were statistically tested. In regard to fawn type *solitaria* the confidence limits of the mean-values were found out. *Conclusions* : (i) Within each group, the females are larger than males in respect of all the body-parts, the sexual dimorphism being greatest in 7-striped *solitaria* and least in *gregaria*. (ii) Regarding E and F among females, and F alone among males, the *regaria* individuals are the smallest, 6-striped *solitaria* larger, and 7-striped *solitaria* the largest. The differences are not significant among the male elytra. (iii) The mean E/F ratio is the lowest in 7-striped *solitaria*, higher in 6-striped *solitaria*, and the highest in *gregaria*.

54. Reduction in Milk Yield in Indian Dairy cattle by arthropod invasion and its control.

B. C. Basu and C. M. Sen-Gupta, Izatnagar.

The paper deals with the result of a series of experiments conducted to determine the reduction in milk yield in Indian Dairy Cattle caused by arthropod invasion and to work out easy methods to control it.

The previous work on this subject is discussed.

55. Distribution of Tabanus Flies and its Correlation with the incidence of Surra in India.

B. C. Basu, Izatnagar.

The paper deals with the regional distribution of the Indian spieces of tabanid flies and its correlation with the incidence of surra in India. The paper is illustrated with charts and tables showing incidence and maps showing distribution.

56. Breeding of *Tabanus rubidus* Wiedemann in captivity.

B. C. Basu, Izatnagar.

Observations on the egg-laying habit of *Tabanus rubidus*, Weidemann in captivity and on rearing of the larvae are reported in this paper.

ECHINODERMATA

57. Observations on the effect of a new antibiotic substance upon sea-urchin eggs.

Alexander Wolsky, Delhi.

The author reports on experiments carried out on eggs of Echinocardium cordatum and Psammechinus miliaris with raphanin, an antibiotic substance isolated from seeds of the radish (Raphanus sativus) by Ivanovics and Horvath (Nature, **160**, 297, 1947). The substance stops mitosis of Echinocardium eggs in a concentration of 1 : 125.000 and disturbs development (prevents gastrulation) in 1 : 2,000.000. Psammechinus eggs are more resistant and there are even individual differences between eggs of the same species as regards resistance. The differences are correlated with the cortical reactions at fertilization (formation of fertilizaton membrane) : the stronger the cortical reactions, the greater the resistance, Resistance also increases during cleavage : in the 2-cell stage the eggs are more susceptible than in blastula stage. These and other observations (unequal cleavage, fragmentation of cytoplasm) indicate that the surface (Cortical layer) of the eggs and blastomers plays an lmportant role in determining the effect of raphanin. Development of cilia and ciliary motion are not affected by concentrations which stop other developmental processes (1 : 250,000). Basal metabolism as measured by oxygen uptake is not depressed by concentrations which stop development (1 : 500.000). Control experiments with the well-known mitotic poison colchicin, were also carried out for comparision.

PISCES AND FISHERIES

58. An adjustable fish pass for the experimental collection of data.

B. Sundara Raj, Lucknow.

Costly fish passes constructed in India have failed because of unsuitability for Indian fish. A successful fish pass can only be constructed after experimentally ascertaining the slope, velocity and discharge negotiable by different species and by the same speices at different ages. The Indian Council of Agricultural Research sponsored a scheme but it could not be worked for want of these data. The transport of fish of all sizes and varieties is impracticable. I have therefore designed a portable and adjustable pass to obtain these data easily in any required place.

The apparatus consists of :—

1. Inlet channel with regulating sluice and removeable bag net to trap ascending fish.

2. Fish pass proper with a slope of 15° and a false adjustable bottom plate with baffles. With this the gradient can be regulated from 15° to 0. The permissible slope of a pass being 1 in 5, the entire range is covered.

3. Resting pool with adjustable net lining. *Method.*—Collect fish and place in the resting pool net after noting sizes and species. Admit a flow of water of known volume, depth and velocity. Adjust flow until fish ascend. Reluctant fish can be coaxed by gently raising the net. Thus the needs of any species and size of fish can be determined.

59. Some Aspects of The Natural History of *Clupea lile*.

H. K. Mookerjee and R. Bhattacharya, Calcutta.

Clupea lile, according to Day, is an inhabitant of the west coast of India. But in the recent collections from canning river this fish has been found in swarms even in the east, *Clupea lile* is not available in Canning river throughout all the seasons of the year, but its availability is restricted to a certain period covering the months from April to October. It migrates in the river in its younger stages and after attaining a considerable size returns again to the sea.

No direct evidence has yet been obtained on its breeding habits, but its young ones are found in the river up to June. Presumably its breeding season prolongs from December to May.

Its growth rate in relation to length, breadth and weight of the body has been studied. In April the Average Mean Length is 25.5 mm., the Average Breadth is 7 mm. and the Average Weight is 353 mg. These A. M. L., A. B. and A. W. of the fish increase gradually month to month and in October they have been recorded to be 72 mm. 25.5 mm. and 2370.4 mg. respectively.

The dietary of *Clupea lile* consists of some algae and benthoic crustacea. Among the algae : *Oscillatoria sp. Ulothriz sp., Hydrodictyon sp, Coscinodiscus sp., Lyngbya sp., Cyclotella sp., Navicula sp.* and some spores are found in its stomach contents. *Daphnia sp., Cyclops sp., Calanus sp., Eubranhciata sp., Mysis sp.*, various kinds of decapods like small shrimps and crabs, and various crustacean stages like Zoea, Megalopa, Cypris, and Nauplius are the chief bodies of the crustacean diet. The percentage of algal diet is not more than 3% in any case.

Silicate matter forms only 2% of the whole stomach contents in the early stages, but over 50 mm. stage it becomes very negligible. Crustacean diet forms the main bulk of the food. Again examining the post-intestinal contents it has been found that most of the algae remain undigested. Evidently it may be said that the fish is a carnivorous one and chiefly lives on crustacea.

60. On some Aspects of the Natural History of *Engraulis Hamiltonii*, and *Engraulis telara*.

H. K. Mookerjee and P. S. Mookherji, Calcutta.

Engraulis Hamiltonii and *Engraulis telara* have a common name Phansa in Bengal. Developing stages of both the species have monthly been collected from a salt water bheri at Ghutiyari Sheriff, 24-Parganas. Stomach contents of both the species at various stages have been examined and found to constitute the same articles of food. They take abundant quantity of crustacea mainly the copepods and macrurans and little amount of vegetable matters embodying some unicellular species of Myxophyceae and Chlorophyceae. Occasionally diatoms, mainly centrics, could be found in the stomach contents. All the previous workers on food of fish examined only the stomach contents and regarded them as food of fish. But we think that this type of work is far from satisfactory for the determination of food. Much depends on the condition of digestion of the food taken. For this purpose we have examined the condition of the post-intestinal contents (contents of the posterior most part of the intestine) of each fish and their average results have been taken. Thus it may be said that the main food of these two species at their different stages is crustacea while the vegetable matters may be regarded as the accessory food or roughage as they are always found undigested or partly digested. Regarding variation of food we can state that it varies with regard to quantity rather than quality in different seasons of all the year round.

The fish possess some sort of selective habit as they take only the animal food (crustacea) when the bheri is rich in both phyto- & zooplanktons. In this case the fish may be called as surface feeder as they devour only the crustaceans which naturally thrive on or near the surface of the water.

Breeding season of the fish begins from January and prolongs up to the end of July. The fry of the two species could be availed as long as to the first part of August.

61. Spawning and development of *Cirrhina reba* (Ham.).

P. I. Chacko, Madras.

This junior carp attains maturity at the end of the first year and spawns in rivers from July to October. The hydrological conditions of the rivers at this period are studied. The fertilised egg is transparent and measures 3.0 mm. in diameter. Segmentation commences within 30 minutes of laying ; and the embryo becomes prominent at the sixth hour. It measures 1.85, 2.2 and 2.6 mm. at the 8th, 10th and 12th hours respectively. The optic and auditory vesicles and the heart appear at the 12th hour. Hatching occurs at the 14th hour ; and the larva measures 3.35 mm. long. Pigmentation commences at the 4th hour. The absorption of the yolk-sac and the formation of mouth coincides on the 3rd day. In the 2nd week the larva measures 11 to 15 mm., and shows a bluish lateral band and 3 to 5 black spots on the caudal fin. It grows 30 mm. long in 6 weeks. The adult features are assumed within 8 weeks. Further details are recorded. The fish attains a size of 10 to 15 inches in one year : and its suitability for rural pisciculture is discussed.

62. On the Bionomics of Buchanan's Carp, *Barbus curmuca* (Ham.).

P. I. Chacko, Madras.

This carp occurs in the rivers of the Malabar and South Kanara districts. The conditions of the hill stretches of four rivers, namely, the Mannantoddy, Panamaram, Netravati and Suruli rivers, in which it breeds during the S. W., Monsoon are detailed. The diet of the fish consists of plantonic organisms and aquatic insects. The migration of the fish is indicated.

63. A study of the Ecology and Bionomics of Indian Carps Catla Catla (ham), Labeo Rohita (ham), Cirrhina Mrigala (ham) Cultured in the sewage Irrigated Fish Farms near Calcutta.

S. P. Basu, Calcutta.

Sewage irrigated fish culture is being carried out in the defuct Bidyadhori spill area (the so-called "salt lakes" Calcutta). Salt lakes cover an area of 75 square miles, of which 50 square miles is marshy and unsuitable for agriculture. Out of these 50 square miles, twenty seven have been converted into fisheries yielding 120,000 maund (4,445 tons) of fish annually. Production can be increased to 3 lakh maunds (11,100 tons) by utilising all the marshy places with proper administration of sewage. Standardization of sewage feeding is, therefore a problem of great economic importance.

Fisheries in this area are shallow and on an average 2′/3″ of water is maintained. Sewage is fed once a month during the summer and winter months, while during monsoon months, the fisheries are drained off to check overflooding. Sewage is allowed to enter against the direction of wind and 30 to 40 million gallons of sewage is mixed with 100-120 million gallons of fishery water slowly in course of 5-10 days, thereby reducing the chance of sudden pollution and fish mortality during sewage feeding. Fisheries are dried up for 1 or 2 months for periodic cleaning of vegetation and drying the bottom. Sometimes paddy is cultivated as an alternating crop to prevent soil getting sewage sick. Different concentrations of sewage in a number of experimental ponds in which dosage and other conditions can be controlled, were tried and experimental observations recorded. Experimental observations have been checked with the observations in bigger fisheries namely Hanakhali and Charchania, 600 and 250 acres respectively.

Typha sp, *Pistia*, *Vallesnaria*, *Hydrilla*, *Ceratophyllum*, *Eichornia*, different species of *Cyperus* and *Lemna*, etc., form the natural aquatic vegetation while *Panicum sp*, *Alternenthera* and *Sweada* form the terrestrial vegetation. A marked seasonal variation in the above vegetation is noted. Vallesnaria with flowering stages is prominent in January and February. Zoo & phytoplankton prominent in summer, moderate in monsoon and negligible in winter. Cladocera prominent in summer, copepoda and rotifer in monsoon and *Tribonema* and *Oedogenium* in winter.

Ophiceephalidae Siluroidea, Anabantidae, and Minnows form a natural bye product in these fisheries in addition to carps cultured therein. In course of a year from 1 cm. fry *Cala catla* (Ham), *Laeo rohita* (Ham), and *Cirrhina mrigala* (Ham) attain a length of 40 cm. 30 cm. and 25 cm. and weigh 1¾th lb. 1½ lb. and 1 lb. respectively.

Sewage fed to the fisheries has 100-115 p.p.m. B.O.D., ; pH 6.8—7, D.O.—nil—1 p.p.m. CO_2 32.5-37.5 and offensive smell and black colour. During sewage feeding, in the zone of pollution—D.O.—nil, pH 7.1-7.3, CO_2—12-20, B.O.D. 70-92.5

and turbidity increased. No aquatic life. Zone of recovery D.O[illegible]6-6.1, pH 8.0-8.2, CO2 1-2, B.O.D. 20-30. Plankton and aquatic life increase. Diurnal fluctuation of D.O. and pH recorded indicate 6-14.6 p.p.m. and 8-9.8 respectively.

In summer B.O.D. decreases to normal after 10-12 days and winter 15-20 days. Increase in phosphate and nitrate from 0.25 to 0.5 and 0.1-0.15 respectively after sewage feeding. Gradation of pH is observed in different places of fisheries according to the amount of submerged vegetation from 7.6-9 respectively. After sewage feeding bacteria increases on the 1st day followed by increase in protozoa and phytoplankton on 2nd and 3rd day. Rotifer and crustacea increase on the 4th and 5th day respectively. Decrease in phytoplankton is followed by the decrease in zoo-plankton.

64. Food habits of the catfish, *Callichrous macrophthalmus* (Blyth).

P. I. Chacko and S. Thyagarajan, Madras.

The food and feeding habit of *Callichrous macrophthalmus* which congregate in the two supply channels of the Mettur Dam in the months of February and March, when the discharge of water is reduced from 750 to 30 Cusecs, are discussed. Fingerlings of *Cirrhina reba* were present in 68 guts, *Labeo kontius* in 38, *L. fimbriatus* in 21, *Barbus stigma* in 16, unidentifiable fish remains in 37, and aquatic insects in 38. Suggestion for checking the adverse effect [illegible] the carp fisheries of the piscivorous tendency of the catfish is indicated.

65. Adaptive modifications in a hillstream cat fish, *Glyptothorax telchitta* (Hamilton)—Part 1. Epidermal Adhesive Organs.

Bimla Bhatia, Delhi.

This paper (part 1 of the series) deals with the epidermal organs which serves adhesive function, in a small fish *Glyptothorax telchitta* found in fast flowing streams of Rihand River, Mirzapore, U. P. Due to the resistance offered by the fish against strong water currents number of epidermal adhesive devices are developed in it which help the fish to maintain a more or less stationary position.

These are :

(*a*) *The Rostral hood*, i.e., the region in front of the mouth which is a secondarily formed covering over the anterior lip. It is pad-like and is profusely papillated subserving an adhesive function. (*b*) *The posterior lip* region is also papillated and the papillae are longer than those in the rostral hood. (*c*) The region of the *Branchiostegal rays* has a grooved integument which bears short stout spines, and (*d*) *The Thoracic adhesive apparatus*, a marked rhomoidal area on the ventral chest region, where the integument is longitudinally pliated. The ridges are provided with long curved cuticular spines which help the fish to stick to the substratum.

66. On factors influencing the reduction of the dorsal fin in some Indian Siluroid and other fishes.

N. N. Majumdar, Delhi.

On a general survey of fishes one comes across a variety of fishes some with long and other with a short dorsal fin. The length of the dorsal fin varies considerably and it seems to depend upon the shape of the body. The greater the lateral compression of the body, the smaller is the dorsal fin. But this lateral compression must be greater ventral-wards, i.e., below the middle line of the body. Such a condition is most apparent in *Wallago*, *Heteropneustes*, *Callichrous*, etc.

The other factor influencing the length of the dorsal fin appears to be the smallness of the abdominal cavity. Fishes with a reduced dorsal fin are carnivorous and as such they have a small length of intestine. To accommodate this small length of the intestine they require a comparatively smaller abdominal cavity. Small abdominal cavity gives less upwards thrust than that of a herbivorous one thereby helping in the reduction of the dorsal fin.

67. On the natural history of the Olive Carp, *Barbus chrysopoma* Cuv. & Val.

P. I. Chacko and B. Krishnamurthi, Madras.

The olive carp contributes to a commercial fishery in the South Kanara and and Tanjore districts. It occurs in rivers and tanks and attains maturity when 5 inches in length. It breeds in river sections having submerged rocks or vegetation, during the rainy season. The conditions of the spawning areas are given. The fish attains a maximum size of a foot within one year. It feeds on plankton, filamentous algae, aquatic insects and worms. A comprehensive analysis of the food organisms is also given.

68. Food Organisms of *Labeo boga* (Ham.).

P. I. Chacko and B. Krishnamurthi, Madras.

Three species of *Myxophyceae*, eight of *Chlorophyceae*, nine of *Diatomaceae*, three of *protozoa*, three of *rotifera* and five of *cladocera* constitute the food organisms of this fluviatile species of Carp. Of these, *Microcystis*, *Spirogyra*, *Amphora*, *Melosira*, *Navicula*, *Euglena*, *Ceriodaphnia* and *Diaptomus* occurred in more than 50% of the guts examined. The highest percentage of thirty in any stomach was formed by *Amphora*, *Melosira* and *Navicula* in separate specimens. The suitability of the species for pond culture is discussed.

69. Prawn shell meal as fish-food.

P. I. Chacko and B. Krishnamurthi, Madras.

The rate of growth of fry of four species of fish, *Labeo kontius*, *Cirrhina reba*, *Barbus hexagonolepis* and *Labeo calbasu*, when fed on prawn shell meal, has been recorded for a periods of four months. The growth is twice greater than the normal growth in the case of *Cirrhina reba* and *Labeo calbasu* and four times in the case of *Labeo kontius* and *Barbus hexagonolepis*. The meal is also relished by other species like *Osphronemus gorami*, *Etroplus suratensis*, *Labeo fimbriatus*, *Garramullya* and *Danio aequipinnatus*. Chemical analysis of the prawn shell meal showed that it contained 41% protein, 6% insoluble matter, 5% fat, 5% carbohydrates, 5% crude fibre and 38% lime and phosphates. This waste product of the prawn curing industry can thus be used for fattening fish.

70. On the scale-pattern of certain Indian Teleosts.

D. N. Ganguly and S. P. Sarker, Calcutta.

The arrangement of scales in a large number of Indian teleostean fishes were studied. It was found that every species possessed a definite pattern which is never repeated in another one. The length-breadth ratio of the euposed surface of the scales of the different species also differs much. According to the authors, the scale-pattern can be used for the specific identifications.

71. On the nature and function of the tongue in fishes.

D. N. Ganguly and S. P. Sarker, Calcutta.

The buccal cavity of a large number of teleostean fishes was examined. It was found that the tongue is present only in those species which snap at anything living and take comparatively big sized swimmers like, fish, fish-fry, prawn, shrimp, etc. The details of the morphology and histology of the tongue were studied and the primary nature of the tongue was also discussed. The study suggested that the tongue of the fish is designed for the prevention of the slipping out of the living prey from the buccal cavity.

72. Notes on the natural history of four species of fish from the Tungabhadra River.

P. I. Chacko and M. J. Mathews, Madras.

(1) *Schismatorhychus* (*Nuhta*) *nuhta* (Sykes) attains 2 feet in size and attains maturity when 10 cm. in length. Its food consists of diatoms and desmids. Its culture in the Bellary fort moat farm has given satisfactory results attaining a size of 10 to 12 inches in 8 months. (2) *Puntius kolus* (Sykes) is one of the commonest carp in the river. It

spawns at the onset of S. W. monsoon. Suitability for pond culture is indicated. Food consists of planktonic organisms and aquatic insects. (3) *Callichrous pabo* (Ham.), is a rare species and its occurance in this region is recorded for the first time. Macrocrustacea, small and young carps, aquatic insects and leeches form its food. (4) *Rita hastata.* (Val.) feeds on caddis fly larvae, water beetles, shrimps and rotifers.

73. Notes on the Grey Mullets (*Mugil spp.*) of Krusadai Island. Gulf of Manaar.

K. Chidambaram and G. K. Kuriyan, Madras.

Grey mullets constitute an important group of fishes hugging the shores of Krusadi and nearby Islands in the Gulf of Manaar. The three important species constituting the fishery are :—

(1) *Mugil troschelii* (Blkr),
(2) *M. waigiensis* (Quoy & Gaim), and
(3) *M. seheli* (Forsk).

The food of these adult and fry of these three species are presented and discussed. The characters for identifying on the field the fry of *M. troschelii* and *M. waigiensis* are given in view of their importance for pisciculturists as the cultivation of mullets in marine and freshwater farms is gaining more importance in this country than ever before.

74. Occurrence of Fish Larvae and Post Larvae in Bombay Waters during 1948-49.

S. V. Bapat and D. V. Bal, Bombay.

The occurrence of larvae throws some light on the breeding season of fishes and so a systematic investigation of young forms of fishes occurring in Bombay waters has been undertaken since May, 1948. Pelagic fish larvae and post larvae have been obtained from plankton samples taken twice every week from waters around Bombay.

During the last year, 2005 young fishes from 118 plankton samples have been studied and assigned to 32 species and 22 genera. Details regarding their occurrence and seasonal fluctuations have been discussed in this paper.

Larvae of *Megalops cyprinoides, Engraulis kammalensis, Hemiramphus ectuntio, Polynemus tetradactylus, Therapon argenteus* and *Apocrypies serperaster* were fairly common in these collections. Further the young forms of *Dussumieria hasseltii, Bregmaceros macclellandi, Trichiurus savala* and *Drepane sp.* have been recorded for the first time from Bombay waters.

75. On the hydro-biological data collected in the Wadge Bank early in 1949.

K. Chidambaram and A. D. Isaac Rajendran, Madras.

Fishing operations were conducted in the Wadge Bank during February, March and April of 1949 with the help of the Madras Fisheries Departmental vessels. This opportunity was availed of in gathering certain hydro-graphical data and Biological data on the fishes of the locality. The chief kinds of fishes examined were *Epinephelus tauvina* (Forsk), *E. miniatus* (Forsk), *E. bleekeri* (Vaill and Bocourt), *E. undulosus* (Q. G.), *Lutjanus malabaricus* (Bl. Schnr) and *Aprion typus* (Blkr.). The summary of the data on their length, weight, sex, condition of gonads and stomach contents is presented in this paper.

76. The Fish-fauna of the Kitham Reservoir, Agra.

Kr. Balwant Singh, Agra.

The author has studied the topography and hydrobiological conditions of the Kitham Reservoir in relation to its fish-fauna. The reservoir is a natural perennial stretch of water, biggest in the whole district, being seven sq. miles in area with a maximum depth of 25 feet, is supplied by the Delhi-Agra Canal, and empties into the river Jamuna by the Kitham Escape. The fishes so far collected belong to 39 species, 25 genera and 9 families, of which some are recorded for the first time from this area. The colour variations and seasonal changes in the various species have been described, and a number of new distinctive features discovered.

77. On a method of trapping fish from floodwater in the rice fields of Assam.

N. N. Majumdar, Delhi.

In this paper an ingenious method of trapping fish from flood water is described. Before the flood comes the inhabitants make a trap by digging pits alongside the rice fields and after the flood subsides the pits which get filled up with water are searched for fishes. This method is found in practice in Assam.

The paper is illustrated with lantern slides showing details of the type of pits that are made for the purpose.

78. A review of Present-Day Fishery Research in U.S.A.

Brahma S. Kaushiva, Lucknow.

79 Effect of different Combination and Concentration of Oxygen and Carbondioxide on Larva, fry a fingerlings of Indian Food Fishes Catla catla (Ham) Labeo rohita (Ham), Labeo bata (Ham) and Cirrhina mrigala (Ham)

S. P. Basu, Calcutta.

In the small universe as is obtained in the usual laboratory set ups i.e. closed system used by earlier investigators, the products of matabolism tend to accumulate and this may not be comparable to field conditions.

Various methods such as de-aeration, sealing the water surface with a layer of oil after boiling and continued boiling were tried to get a continious flow of water. Finally a simple apparatus has been standardised by the author which deliver 1200-1500 c.c. of deoxygenated water with 0.05 p.p.m. or less per minute. A new technique based with varying proportion of O_2 and CO_2. A long tube with inlet and outlet has been taken which has a constant supply of tap water and O_2 and CO_2 is bubbled from cylinder through a bent tube in it at definite pressure. The advantage of passing the gas through a bent tube is that the size of the bubbles, time of exposure of each bubble and number of bubbles are controlled. The water charged with gases is drawn to the aspirator bottle from the middle of this straight tube so that remaining half of the water column above the inlet tube serves as a balancing column. This procedure provides an uniform concentration of the gases in the water supplied to the aspirator bottle in which deoxygenated water is also delivered at the bottom. The apparatus has a constant supply of cold water from tap at the same rate as the outflowing water through experimental flasks. Rate of flow and temperature can be controlled in the apparatus.

Larvae, fry and fingerlings of Indian carps *Catla catla*, *Labeo rohita*, *Labeo bata* and *Cirrhina mrigala* measuring 4-5 mm. 1-2 cm. 4-8 cm. and 10-16 cm. in length and on an average weight varying from 1.1-1.2 mg. .08-0.1 gms. 0.25 to 0.4 and 8-16 mgs. were exposed in a continuous flow system carrying oxygen concentration of the order of 0.1, 0.5, 1, 2, 3 and 4 p.p.m. of O_2.

The results indicate that larvae and fry upto 8 cm. can live in water containing 0.5 p.p.m. for 24 hours or more provided other conditions remain optimum. They die within a short time below 0.5 p.p.m. of O_2.

The fingerlings (10-15) cm. cannot stand O_2 below 1 p.p.m. and die within short time, whereas they can continue for 24 hours or more in 1 p.p.m. of O_2 other conditions remaining optimum. Gold fish was used as a test animal and the result shows that it can live in 0.5 p.p.m. of O_2.

The larvae and fry (4-5 mm. and 4-8 cm.) were also subjected to a combination of 0.5, 1, 2 and 3 p.p.m. of O_2 with 2.5, 5, 7.5, 10, 12.5, 17.5, 30, 60, 100, 125, 150, 175, 200, 250 p.p.m. of CO_2 to find out the respiratory metabolism of fishes in different levels of O_2 and CO_2 and also the minimum and maximum CO_2 optima.

The results indicate that larvae cannot stand 0.5 p.p.m. of O_2 with 2.5 p.p.m. CO_2, with 1, 2, 3 and 4 p.p.m. of O_2 it can stand upto 7.5 p.p.m. CO_2. In case of fry (1.2 and 4-8 cm.) it can stand 0.5 p.p.m. O_2 with 15 p.p.m. CO_2 but die in 0.5 p.p.m. O_2 with 17.5 p.p.m. CO_2, when O_2 is increased to 1, 2, 3 and 4 p.p.m. the fry can stand 125 p.p.m. CO_2, half of it dies in 150-175 p.p.m. CO_2 and all die between 175-250 p.p.m. CO_2. The fingerling (10-15 cm.) can stand 2.5 and 5 p.p.m. of CO_2 with 1 p.p.m. O_2 and with 7.5 p.p.m. CO_2 *Catla catla* and *Labeo bata* die. *Cirrhina mrigala* and *Labeo rohita* can stand 1 p.p.m. O_2 with 10 p.p.m. CO_2. All the fish die at 1 p.p.m. O_2 and 12.5 p.p.m. CO_2 except gold fish which can tolerate 100 p.p.m. CO_2 with 1 p.p.m, O_2 but feels uncomfortable at 150 p.p.m. CO_2 and dies in 200 p.p.m. When O_2 is increased to 2 to 4 it can stand 200-250 p.p.m., CO_2. The results further indicate that in the case of fingerlings there is a minimum and maximum CO_2 optima, which is absent in the case of larvae and fry upto 8 cm. Temperature and activity of fishes has a distinct effect on O_2 requirements. Further detailed work on the fore going aspect with hypertension of O_2 and CO_2 is in progress. Miligram of O_2 used per gram body weight per hour, pH, alkalinity, temperature, electrical conductivity, rate of flow of water in c.c. per minute and the behaviour of fishes at different oxygen and CO_2 levels have been recorded.

80. The Role of Banana Steam and its Juice in Controlling Hydrogen ion Concentration of Fish Ponds.

S. P. Basu, Calcutta.

Indigenous practice of using banana stem and juice by the fish farmers of Bengal, during mortality of fishes in ponds has been described. Field observations in some ponds in Singur, Bengal, treated with banana stem during mortality of fishes have given satisactory results.

With a view to understand the basic scientific principles involved and to standardise this practice on a commercial basis, experiments on the effect of addition of banana stem and its juice to varying concentrations of CO_2 have been carried out.

The results indicate that banana stem juice has an acid pH (5.2-5.7) and contains considerable amount of methyl orange alkalinity. When pond water is treated with banana stem or its juice, the pH of the pond water is reduced slightly but its buffering capacity increases considerably due to added methyl orange alkalinity.

32·5 p·p·m· of CO_2 changesp H of pond water by 0·7 units whereas the same water treated with banana stem or its juice requires CO_2 of the order of 150 p.p.m. to lower the pH to that extent.

Various types of pond water treated with different varieties of banana stem or juice gave almost the same result.

81. Experiments on the Transport of Larvae of Indian Craps with oxygen in a closed System.

S. P. Basu, Calcutta.

Experiments on the transport of larvae of Indian Carps. *Catla catla* (Ham.), *Labeo rohita* (Ham), *Cirrhina mrigala* (Ham), *Labeo bata* (Ham) etc. were carried out in a series of experimental flasks of 3500 c.c. capacity with different concentrations of larvae and displacing half of the water of the experimental flasks with oxygen. D.O., CO_2, alkalinity, temperature, turbidity, residual chlorine and electrical conductivity determined before and after experiment.

The results indicate that in spite of the presence of oxygen, the larvae died due to high CO_2, the bacterial population and decomposition of dead larvae inside the flasks.

The amount of O_2 required by larvae and the production of CO_2 is negligible. Secondary growth of other organisms in the medium demand more O_2 and produce CO_2 as a result of putrefaction of dead larvae.

Disinfectants like $KMnO_4$ in concentrations of 1 in 100,000, 200,000 and 500,000 and chlorine in concentration of 0.5 and 1 p.p.m. was tried to supress the bacterial population. Continuous disinfection with silver electrode was also used to control bacterial activity. In addition marble chips were used to control pH in the medium. Chlorine and silver electrode with merble chips gave good results. $KMnO_4$ was not suitable for the purpose.

An attempt is being made to evolve a standard transport can making use of the above findings and observations.

AMPHIBIA

82. The Heart of Rana tigrina Daud.

B. C. Mahendra *and* Hira Lal Sharma, Agra.

The authors have studied the minute anatomy of the heart of *Rana tigrina* Daud, in several series of transverse, frontal and sagittal sections and have discovered a number of features, not hitherto described. Each vena cava anterior, before opening into the sinus venosus, forms a dilatation, separated from the sinus by a neck-shaped constriction bearing a pair of valves. The sinuauricular aperture is not "transverse oval" as previously described, but transversely directed, sub-triangular in appearance. The walls of the pulmonary veins are arterial in structure and open into a recessus pulmonalis. The coronary sulcus is not transverse, but oblique. The septum atriorum extends beyond the atrio-ventricular aperature into the lumen of the ventricle and is united to both the dorsal and the ventral valve. The bases of these valves are supported by nodules of elastic fibres. The auricles open into the ventricle by a short cavity, bearing four valves. The ventricular space is neither single nor central, as usually believed, but can be divided into five cavities (the atrio-ventricular, central, right and left antero-lateral, and apical), which have been studied in detail. The internal structure of the truncus arteriosus and the exact disposition and origin of the arches also show important details differing from previous description.

83. Abnormality in Arterial System with Changes in Urogenital Organs of a common Indian toad, Bufo melanostictus Schneid.

Birendrakumar Mitra, Calcutta.

An unusual case of abnormality in arterial system with changes in urogenital organs of a common Indian toad, *Bufo melanostictus* Schneid, has been studied. Brief reference to the courses of arterial arches and their main branches is given. Changes in urogenital organs are also described here. Origin of Coeliaco-mesenteric artery from the only systemic arch of the right side, has been redefined. Pigmentation of the sub-gular and abdominal skin, presence of vocal sac, stout and swollen fore-arms with nuptial pads or excresences as found by Liu. (1935, 1936) are tenable here. A few prominent skeletal muscles, linea alba and linea masculina which are so characteristic of a normal male toad of Indian type, are present in this specimen which otherwise appeared to be a healthy full grown male toad.

Hypertrophic carotid labyrinth or the so called carotid gland of the left internal carotid artery has been described as an organ responsible for raising the blood pressure of the defective circulation through the heart which has hypertrophic ventricle and bulbus cordis.

Attention has been drawn to the histology of certain endrocrine and urogenital organs. So far as the present author is aware, some of the anatomical peculiarities noted above are remarkable and have not been recorded in the Anura. The problem of tracing them to the structural peculiarities is now engaging his attention.

84. On the Food of the Common Pond Frog, Rana hexadactyla Less, with special reference to pisciculture.

P. I. Cnacko *and* B. Krisnnamurthi, Madras.

A qualitative and quantitative analysis of the gut of 250 specimens of *Rana hexadactyla* indicates that the food of this amphibian consists mainly of water insects, wate plants and leazes and flowers of shore trees. Fisheso of small size and yf uneconomical importance were found in five stomaches nnly. The improbability of the frog adverselʎ affecting qsy production is discussed.

85. The Closure of the Nares in Rana tigrina Daud.

Chandra Pal Singh *and* B. K. Randhar, Agra.

The authors have performed a series of careful experiments on the closure of the narial apertures in *Rana tigrina* Daud. The hitherto accepted view that the closure is effected by the elevation of the tip of the lower jaw playing against the premaxillaries and forcing them upwards to close the nostrils, seems to be untenable.

REPTILIA*

86. The Venous System of Varanus monitor (Linne).

Surendra Sharma, Agra.

The venous system of *Varanus monitor* (Linne) was studied in details. The more important features discovered by the author are as follows :—

1. The Precaval vein is the backward extension of the internal jugular.
2. The Vena azygos arises from the precaval on the right side, is connected with the supra-renal portal system of that side by the dorsal parieto-hepatic vein, and breaks up into a number of vertebral veins on the left side.
3. The vena prebrachialis ends on the dorsal side of the shoulder, and the vena axillaris extends on the preaxial border of the upper arm.
4. The external jugular vein is variable in its disposition and in the number of its plexuses.
5. The renal veins arise intra-renally.
6. On the left side a vein from the vertebral column forms part of the supra-renal portal system.
7. The venae pelvicae are continuations of the femoral.
8. A vena epigastrica media is present.
9. The femoral vein is connected with the renal portal.
10. The united ischiomesenterics continue as a component of the hepatic portal system.
11. A pair of venae inguinalis is present.
12. The vena gastrica anterior is a vein separate from the anterior abdominal, and the vena gasterolinealis and the vena intestinalis posterior unite to form a vena intestino-gastero-linealis which forms part of the hepatic portal system.

AVES

87. Some observations on the shank colour of Indian fowls.

B. R. Sen-Gupta, H. P. Tandon *and* S. G. Iyer, Izatnagar.

The behaviour of dark and yellow shank colourations in an improved strain of Indian fowl has been studied by breeding experiments. In certain matings, among the first generation progeny, the dark colour predominated over the yellow. The results also revealed no association of dark or yellow shank with sex. Out of the four matings made, in one mating, however, there was a suggestion that the parental stocks would breed true to the character, in this case dark shank colour. In the case of two reciprocal matings 50% of the progeny were dark and 50% yellow.

88. Some observations of feather colourations in Indian fowls.

B. R. Sen Gupta, H. P. Tandon *and* S. G. Iyer, Izatnagar.

Amongst the fowls of an improved indigenous strain, sexual dimorphism, parti coloured varieties and the nature of the Brown Leghorn plumage pattern have heen recorded. The incidence of this character was high in the first generation progeny.

MAMMALIA

89. Prognathism and facial angle of Pteropus giganteus giganteus.

A. Ananthanarayana Ayer *and* K. I. Verghese, Madras.

In a tracing of the median sagittal section of the skull made by standard anthropometric technique, the following points are marked : Opisthion, OP ; Basion, B ; Presphenoidal point, PR ; Nasion, N. and Premaxillary point, M ; B.PR. is the cranial axis and PR.M. is the facial axis. The angle B.PR.M. is the sphenomaxillary angle or facial angle. Its value in *Pteropus giganteus* (Megachiroptera) is 142 degrees and in *Rainopoma microphyllum* (Microchiroptera) is 130 degrees. This angle is a reliable guide indicating the measure of facial prognathism and Megachiroptera have a larger facial angle, i.e. are more prognathous, thus confirming their more primitive evolutionary status as compared with Microchiroptera.

The paper also gives the values of the spheno-ethmoidal angle and the foramino-basal angle in the two tribes. Megachiroptera have 175 and 110 respectively for these angles and Microchiroptera have 162 and 121 for the same angles. This also indicates, from the point of view of cerebral development, that Megachiroptera have a more primitive brain than Microchiroptera.

A table of values of these angles for other animals for comparison, compiled from different authors, is also given.

90. Thoracic shape and thoracic index of Pteropus giganteus giganteus.

A. Ananthanarayana Ayer *and* K. I. Verghese, Madras.

There is a close similarity between the shape of the thorax of *Pteropus* and that of man in their ventro-dorsal flattening, contrasting with the side to side flattening in most lower mammals. The thoracic index is the ratio of the antero-posterior diameter to the transverse diameter of the thorax, the choice level for measurement being that of. the 4th rib cartilage. The diameters were measured with anthropometric calipers. Observations were made on four specimens. The thoracic index in *Pteropus* varies from 79 to 88 with the average at 83. The probable causes for the similarity between the indices of man and Pteropus, two unrelated animals with entirely different mode of life and locomotion are suggested.

1. The verticality of the vertebral column cannot influence the shape of the thoracic cavity of the bat as the hooked pedal attachment by which the animal is suspended is higher and the centre of gravity is lower. 2. The weight of the abdomianl viscera gravitating to the cup of the diaphragm tends to change the thoracic outlin to a cask shaped one. But this cause could not produce a ventro-dorsal flattening. 3. The pull of the powerful pectoral muscles attached to the chest tends to draw the ventral part of the thoracic wall dorsally and laterally. This is an important factor effecting dorsoventral compression and lateral elongation of the thorax. 4. The lungs in *Pteropus* naturally requiring a high level of functional efficiency could not conveniently expand towards their bases due to the hinderance of the supernatant abdominal viscera on the diaphragm. Hence the lungs necessarily expand laterally tending to increase the lateral diameter of the thoracic cavity. This is a major factor in producing the thoracic shape. The relative importance of the causative factors in man and *Pteropus* is thus different.

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PART IV

CONTENTS

1. LATE ABSTRACTS

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PROCEEDINGS
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POONA, 1950.

PART IV

LATE ABSTRACTS

Section IV.: CHEMISTRY.

1. Phosphate Absorption by Soils Part I.

R. R. AGRAWAL & RAM NATH, Kanpur.

A short review of the work done on phosphate fixation in soils has been given. Phosphate absorption by one of Kanpur soils has been determined in few cases and it is found to be dependent upon its concentrations in the soil solution. The absorption is very much lowered in the presence of Ammonium Oxalate, the excess of which even reverses the absorption at low concentrations of phosphate in solutions. The phenomena are expressible by the Fraundlish equation and to this extent resemble many other absorption. But the process is not instanteneous and may continue for a long time.

2. Effect of Inhibitors of Glycolysis in Citric Acid Fermentation.

M. DAMODARAN & P. N. RANGACHARI, Poona.

For the elucidation of the intermediary metabolism of *Aspergillus niger* in the citric acid fermentation one of the crucial questions to be answered is as to the existence of glycolytic reactions. Previous investigations on this question by the use of inhibitors of glycolysis, iodoacetate and fluoride have not yielded conclusive results. The effect of iodoacetate, fluoride and phloridzin have been investigated in detail regarding the influence on the growth and metabolism of *Aspergillus niger*.

Iodoacetate added in concentrations ranging from M|400 to M|1000 to preformed mycelium of *Aspergillus niger* on a glucose medium completely inhibited both utilisation of sugar by the fungus and acid formation. Fluoride at a concentration of M|150 resembled iodoacetate in suppressing both acid formation and sugar utilisation but at lower concentrations, M|200, M|250, and M|300, acid formation alone was suppressed; sugar was still utilised but only at about half the rate of normal controls. Phloridzin in concentrations of M|50 and M|100 completely inhibited acid formation but did not prevent sugar utilisation. At a concentration of M|150 the acid formation was reduced to 50% but sugar utilisation was normal. Phloridzin in concentration of M|10 to M|150 when used along with Currie's medium and inoculated with the fungus spore, did not prevent sugar utilisation but inhibited acid formation only to about 30 to 50%. The uptake of inorganic phosphate from the culture medium was the same as that in the control.

3. Sources of Nitrogen and Citric Acid Formation.

M. DAMODARAN & S. DUTTA, Poona.

Although the production of citric acid by the fermentation of glucose and cane sugar by *Aspergillus niger* is in commercial use, it is well known that the fermentation is extremely sensitive to the raw materials used as a source of sugar. As part of an investigation on the various factors in the culture medium which determine the course of the fermentation the influence of various organic sources of nitrogen especillay aminoacids has been studied. The following substances were used: asparagine, aspartic acid, glutamic acid, glycine, leucine, lysine monohydrochloride, casein and egg albumin hydrolysates and urea. It was found that the nature of the nitrogen source profoundly influenced not only the growth of the fungus mat but also the amount and nature of the acid formed. With asparagine, urea and glutamic acid citric acid formation was not much lower than with ammonium nitrate (between 50 to 60%). In the case of protein hydrolysates and aspartic acid the amount of acid formed was appreciably lowered (between 30 to 40%) and with lysine monohydrochloride it was very much lower (about 15%). With leucine acid formation was largely suppressed. Glycine was found not only to suppress acid production but also alter the nature of the acid formed, oxalic acid being the main product of the fermentation.

4. Modification Caused by the Processing of Cellulosic Materials.

P. B. SARKAR, Calcutta.

Degradations of cotton goods during bleaching and dyeing are considered. Damage may be caused by air in presence of hot alkali during kier boling or by the uncontrolled action of hypochlorite solution—oxycellulose being formed in both cases; degradation may as well be caused by uncontrolled use of dilute mineral acids during souring—hydrocellulose being produced. In either case loss in strength may be considerable depending upon the degree of attack. The rate of oxycellulose formation is dependent upon concentration of the hypochlorite, temperature, its pH, etc; the maximum degradation occurs at or near about pH 7. Certain metals *e.g.*, iron or copper accelerate oxidation of cellulose by hypochlorite. During bleaching of cotton goods with hydrogen peroxide, copper or iron accelerates its decomposition and causes tendering by oxycellulose formation. After souring if the goods are not thoroughly washed, traces of mineral acids adhering to the material get concentrated on drying and degrades it by forming hydrocellulose. The chain-length is shortened and cuprammonium viscosity falls. Acid-producing salts such as calcium or magnesium chloride degrade cellulose likewise. Certain vat dyes cause tendering of cellulose in light and air. Sulphur blacks on storage may liberate acid which attacks the cellulose. Residual oxidising agents or oxygen carriers used in dyeing with aniline black may degrade cellulose. Loosely bound sulphur in sulphur dyes may get oxidised and attack the cellulose.

5. Microbiological Degradation of Cellulose.

S. N. BASU, Calcutta.

The first researches were confined mostly to bacterial attack on filter paper, a number of end-products being obtained from diverse type of bacteria. Later, fungal decomposition of cellulose was found to be of greater importance in several fields, *e.g.*, in the decay of cellulosic textiles and wood. In the former, the lower fungi are mainly active, in the latter the higher fungi, which sometimes can decompose lignin in addition.

Degradation is supposed to follow a hydrolytic path to glucose which is then fermented along various routes. An oxycellulose theory originally proposed by Winogradsky has not found much support. On the other hand, the hydrolytic theory is supported by later work, *e.g.*, identification of different hydrolytic enzymes, accumulation of glucose, and the recent work of Nord *et al.* who have identified identical dissimilation products from glucose and cellulose fermented by the same organism.

Degradation of true cellulose is favourably or unfavourably affected, perhaps to a greater extent than generally realised, by numerous external factors, many of which are possibly not even known. Some of these will be briefly reviewed.

6. Mechanism of Accelerated Oxidation of Cellulose.

G. M. Nabar, Bombay.

The abnormal degradation of cotton cellulose dyed with certain vat yellows, oranges and reds on exposure to light in presence of air or hypochlorite solutions was first systematically investigated by Scholefield and Patel, and later by Derrett-Smith and Nodder. Scholefield and Turner postulated that in presence of light the vat dye is reduced to the leuco compound, which during reoxidation to the parent dye brought about an enhanced oxidation of the cellulose substrate. Oxidations of this type are well known in organic and inorganic chemistry. Other examples of enhanced oxidation of cellulose in presence of another oxidisable substance, are (i) oxidation of cellulose by dichromate in presence of oxalic acid and (*ii*) accelerated oxidation of cotton cellulose impregnated with ferrous hydroxide on treatment with sodium hypochlorite.

Nabar, Scholefield and Turner confirmed the activating effect of the reduced vat dyes on cotton in hypochlorite solutions. They found that this enhanced oxidation is brought about in the course of a few seconds required for the oxidation of the leuco vat dye to the vat dye, and an equivalent degradation of cotton cellulose in absence of the accelerator requires a few hours treatment with hypochlorite. The measured chemical properties of the accelerated oxidation oxycelluloses showed simple relationships among themselves. No such relationship was observed in the case of exycelluloses prepared by action of sodium hypochlorite on cotton cellulose, studied by them in great detail. In the case of prolonged oxidation, the properties of the products obtained varied depending on the pH of the sodium hypochlorite solution used for oxidation. On the acid side of the neutral point, the reducing type of oxycelluloses are produced while on the alkaline side the oxycelluloses produced are of the acidic type.

One of the important properties of the accelerated oxidation oxycelluloses described above was the constant ratio between the copper number and carboxyl content over the whole pH range. This suggested a straightforward oxidative attack uncomplicated by side reactions.

With a view to elucidate the mode of the accelerated oxidation and examine the possibility of explaining the relationship between the copper number and the carboxylic acid content of the oxycelluloses, the present investigation was undertaken. Samples of accelerated oxidation oxycellulose were prepared, carefully washed and dried. The various chemical properties of the oxycelluloses thus obtained were determined before and after treatment with chlorous acid.

From the analysis of the results obtained it is concluded that accelerated oxidation oxycelluloses possess the following chemical properties:

(i) Free carboxylic acid groups
(ii) Free aldehyde groups
(iii) Alkali labile groups unaffected by chlorous acid, but which are amenable to alkaline oxidation

(iv) The ratio of the free reducing groups and the alkali labile reducing groups is unity and that between free aldehyde groups and carboxylic acid groups is constant.

7. Degradation of Cellulose by the Action of Chemicals.

A. B. SEN GUPTA

There are two types of degraded celluloses namely oxycellulose and hydrocellulose. When degradation is produced by the action of oxidising agents, the product is known as oxycellulose while that obtained with acids is called hydrocellulose. Since the reaction takes place in a heterogeneous system, the attack on cellulose possibly proceeds in a topochemical fashion.

Formation of oxycellulose is an invariable accompaniment of a bleaching operation resulting in a considerable reduction in strength. The hydroxyl groups of cellulose are easily changed either to aldehydes or carboxyls and at the same time cleavage in glucosidic chain may take place. Nitrogen dioxide, however, preferentially converts the primary hydroxyls to carboxyls. On the other hand, periodic acid oxidises secondary hydroxyl groups to aldehydes resulting in a rupture of the pyranose ring. This product is very sensitive to alkali which effects the hydrolysis of the neighbouring glucosidic linkage.

An appreciable degradation of cellulose occurs even by the action of air in presence of a strong alkali accompanied by an increase in carboxyl content and cleavage in glucosidic linkages.

By the action of mineral and even organic acids cellulose is considerably weakened as a result of hydrolysis of the glucosidic chain with increase in aldehyde and hydroxyl groups.

8. Degradation of Cellulose.

DR. K. VENKATARAMAN, Bombay.

The photochemical oxidation of cellulose is greatly accelerated by many yellow and orange vat dyes, some of which have excellent fastness otherwise; some indeed are themselves fast to light, but pass on the energy of light absorption to the cellulose molecule which then decomposes. Yellow and orange vat dyes for curtains must therefore be chosen with care. Fast yellow and orange dyes for cotton free from this defect are available and dye manufacturers have mostly withdrawn the dangerous dyes from the commercial range; however Calco Yellow 5G, an American equivalent of Cibanone Yellow R, which is the dye of choice for studying the photochemical degradation of cellulose and was withdrawn by the Ciba Company several years ago, has been recently introduced into India. Further, photochemically active dyes are still employed for calico printing because of their suitability from the printer's point of view. It is known that oxidations and reductions involving one-electron changes proceed very rapidly, and it is suggested that the photochemical action of some of the anthraquinone vat dyes is related to resonance stablization of semiquinone ions. The constitution assigned to Cibanone Yellow R by Fierz-David has been shown to be erroneous.

9. Degradation of Cellulose.

DR. J. K. CHOUDHURY, Calcutta.

Degradation of Cellulose could be classified in the following four classes:—

(*a*) hydraulytic
(*b*) oxidative
(*c*) actinic
(*d*) microbiological.

All the above aspects were ably dealt with by various speakers but the problem of preventing and controlling degradation is of considerable importance for both scientific investigations and industrial practice. This problem has not been dealt with by various speakers. As hydraulysis of cellulose results in the production of glucose, it is worth while to investigate if hydraulytic degradation could be controlled effectively by using baths of varying amounts of cellodextrin, cellobiose and glucose. It has been stated that if one of the three hydroxyl groups of the anhydroglucose present in cellulose be substituted by acetyl or any other group, the product becomes resistant to mildew. No explanation of their behaviours has been forthcoming, Further investigations in this line seemed necessary.

10. The cation-binding capacity of Kaolinite in relation to the nature and extent of the outer surfaces of its particles.

K. S. Rajagopalan, Delhi.

Crystals of Kaolinite have platy habit. They readily take up cations from contact solutions. One mechanism of this phenomenon which has been suggested is that the cations are taken up in exchange for H^+ ions dissociated from the exposed OH groups of the crystals, by far the greater majority of which are on cleavage planes. According to another point of view, the cations are taken up at the lateral surfaces of the platelets by unsatisfied negative valencies which are believed to be developed there as a result of lattice termination. Shaw has estimated the axial ratios of kaolinite crystals having different particle sizes. We have calculated both the lateral surface (S1) and the cleavage surface (S2) per 100 gms. of the platelets from his data. Knowing that one monovalent cation can be taken up per 20 sq. A of the lateral surface, the cation-binding power for an area equal to S1 sq. A is found to be much smaller than the actually determined value. The cleavage area per OH group is roughly 24.0 sq. A. The calculated cation-binding power for an area equal to S2 sq. A is in fair agreement with the observed value.

11. Acitivity coefficients of H^+ ions at the edges, corners and on cleavage planes of hydrogen micas.

R. P. Mitra and K. S. Rajagopalan, Delhi.

Each K^+ ion inside a large mica crystal is bonded to twelve oxygen ions forming two hexagonal rings, one above and the other below the K^+ ion. Platelets obtained by grinding the crystal have K^+ ions exposed mostly on the cleavage surfaces, the lateral surfaces also containing a small number of them. Assuming that the cleavage has been perfect, each K^+ ion on the cleavage plane will be bonded to six oxygen ions. A K^+ ion the edge of the plane will have fewer oxygen links and the number of such links will be still less for a K^+ ion at a corner. All the exposed K^+ ions can be extracted with a dilute mineral acid. The H^+ ions acquired by the surfaces of the platelets in exchange for their exposed K^+ ions give a definite acid character to an aqueous suspension of the acid treated mica. The concentration of free H^+ ions as calculated from the observed pH of the suspension is, however, much less than the total concentration of H^+ ions, as obtained by electrometric titration with a base. The average activity coefficient of the H^+ ions associated with the crystals, is therefore, much smaller than unity. The H^+ ions at the corners make the largest contribution to the observed H^+ ion activity as they are practically free H^+ ions being bonded to the surface by the smallest number of oxygen links. A smaller contribution will be made by the H^+ ions at the edges and the smallest by the H^+ ions on the planes. A weak inflexion in the tritration curve which is observed at a much lower pH than the inflexion which gives the quartity of H^+ ions replacing the exposed K^+ ions, appears to indicate the H^+ ions at the edges and corners and the inflexion at about pH 9.0 indicates all the H^+ ions i.e., those at the edges and corners and also on the planes, acquired in exchange for the exposed K^+ ions of the lattice.

12. The acid character of hydrogen micas in relation to the distance of the negative charge which balances the posi-charge of H^+ ions on the surface.

R. P. Mitra and K. S. Rajagopalan, Delhi.

H^+ ions acquired by the surfaces of minute crystals of mica in exchange for their exposed K^+ ions balance negative charges of the lattice arising from the isomorphous replacements of cations like like Si^{+4} and Al^{+3} by others having smaller positive charges. In hydrogen muscovite, the seat of this negative charge is in the tetrahedral layer immediately below the surface. In hydrogen lepidolite, on the other hand, the negative charge resides in the more distantly situated octahedral layer. Because of the greater separation of the balancing negative charge in lepidolite than in muscovite, a weaker electrostatic link between the H^+ ions on the surface and the rest of the crystal is expected in the case of lepidolite. In agreement with this deduction from crystal chemical considerations, hydrogen lepidolite behaves as a stronger acid than hydrogen muscovite. This is shown by (1) the fact that an aqueous suspension of hydrogen lepidolite gives a lower pH and a greater specific conductance than that of hydrogen muscovite, the concentration of the suspension and size of particles being the same, and (2) the stronger buffer action against additions of bases which is observed in the case of hydrogen lepidolite compared with hydrogen muscovite.

13. Electrochemical criteria for distinguishing between the allied clay minerals, montmorillonite and nontronite.

R. P. Mitra and H. B. Mathur, Delhi.

Nontronite is believed to be the 'iron analogue' of the more common clay-mineral, montmorillonite, judged from chemical compositions, X-ray diagrams, refractive indices and the common physical property of inner crystalline swelling. Both have high base-exchange capacities. Differences however are noticed if the features of the potentiometric titration curves of hydrogen or acid forms of the two minerals are compared. While the titration curve of hydrogen montmorillinite usually shows only one inflexion—two inflexions have been found in some cases—hydrogen nontronite prepared from a pure specimen of montronite showed three inflexions in its titration curves. The inflexions occurred at pH's 4.5, 5.5 and 7.5, Breaks corresponding to these inflexions were found in the conductometric titration curve of the hydrogen montronite.

14. Electrochemical character of hydrogen attapulgite.

R. P. Mitra and H. B. Mathur, Delhi.

The 2.0 micron fraction of a pure specimen of the clay mineral, attapulgite, was repeatedly leached with dilute hydrochloric acid to obtain the so called hydrogen attapulgite. A 0.83% aqueous suspension of the hydrogen attapulgite had pH equal to 4.2 Potentiometric titration curve of the suspension with KOH or $Ba(OH)_2$ showed three inflexions at about pH's 4.80, 7.5 and 10. The amounts of acid (per 100 gm. of hydrogen attapulgite) which were neutralised at the three inflexions were, respectively, 3.0. 24.0 and 52.0 milliequivalents using $Ba(OH)_2$ as the titrant base. 100.0 gms of the hydrogen attapulgite also took up 24.5, 25.4, and 54.6 milli-equivalents of Ba^{++} on being leached with normal solutions of $BaCl_2$ having pH's 5, 7 and 9, respectively.

15 Contribution of hydroxyl groups of layer-lattice silicates to their cation-binding power.

R. P. Mitra and K. S. Rajagopalan, Delhi.

It is genrally believed that the capacity of layer-lattice silicates to take up cations from 'contact' solutions is due partly to such mono- and bi-valent cations of the solid crystal lattice as have large co-ordination numbers and are accessible and partly to the unsatisfied negative valencies which are thought to be developed on the lateral surfaces of the crystals as a result of lattice termination. Mitra and Rajagopalan (Ind. Jaur. Phys. Vol 22, Part III, 1948) have given arguments to show that the latter part of the theory is not tenable. Experimental evidence is now given to show that the part of the total cation-binding power which has been previously ascribed to the so-called negative "broken-bonds" created at the lateral surfaces of the crystals is really accounted for by the fact that the crystals take up the necessary amount of cations in exchange for H^+ ions of their accessible OH groups. An exact comparison of the two parts of the total cation-combing power is possible in the case of muscovite KAl2 (AlSi3) O10 (OH)2. Finely ground muscovite mineral readily exchanged its exposed K^+ ions for the cations of a contact solution. For each K^+ ion which is exchanged, the H^+ ions of two OH groups should be exchangeable. This is actually found to be the case. The total base exchange capacity of the mica-like clay mineral, illite, is similarly accounted for. In the case of clay minerals like kaolinite and pyrophyllite which do not have mon—and bivalent cations having large co-ordination numbers in their lattices all the cation binding power arises from the ability to exchange the H^+ ions of their exposed OH groups.

Section V: GEOLOGY.

1. Note on the Occurrence of Ryolite-Tuff in Surguja, Central Provinces.

Ajit Kumar Saha, (Calcutta).

The paper describes a group of rocks consisting of rhyolitetuff amphibolite, granite and pegmatite, occurring on the banks and the bed of the Rer river, about a mile to the west of Karanji (23° 16' 30" : 82 58' 30") in Surguja State (now merged in the C. P.).

The rock outcrops at the locality were mapped on the scale of 1" x 200 ft. The amphibolites, which are the eldest rock in the area and are intruded by small granite dykes and veins, as well as pegmatite and quartz veins, are derived from metamorphism of basic igneous rocks. Field relations of the rhyolite-tuff which occurs in only one outcrop occupying about 4000 sq. ft. are not clear; but from the fact that rock is only slightly metamorphosed, it is considered younger than the amphibolities. A number of fragments of quartzite, granite and aplite, ranging from 2" to 8" in diameter is found in the rhyolite-tuff. Orientation diagram of quartz in the rhyolite indicates a very low grade of metamorphism of the rock and also gives a probable indication of the flow of the lava. Petrography of the different rock-types have been studied in detail.

Section VI: BOTANY.

1. Parasitic Nature of *Marasmius Rotula* Fr. on *Derris Sinuata.*

R. C. LACY, (Patna).

The genus *Marasmius* has been reported in India on various substrates, chiefly of saprophytic nature. Only a few species have been reported as parasitic.

Marasmius rotula Fr. has not yet been reported as a parasite. It was found growing parasitically on *Derris sinuata*, a Leguminous tree, which is grown in gardens for ornamental purposes. The study of the host and parasite relation showed that it was a very mild sort of parasitism and there was apparently no damage done to the host plant.

The fungus is chiefly confined to the stem region near the ground and shows a perennial, creeping habit with numerous fruit bodies from the same stalk. No haustoria were seen in the preparations. The stipe particularly showed perennial nature. The fructifications appear in large numbers, chiefly after a heavy shower of rain and during the monsoons. During the remaining part of the year, dry stalks persist on the host like the bristles, without the caps.

2. A Contribution to the Embryology of *Mimosa hamata.*

V. R. DNYANSAGAR, (Nagpur).

The paper deals with the embryology of *Mimosa hamata* a large straggling and very prickly shrub of Mimosaceae.

1. The archesporium in an anther differentiates at an earlier period. The anther wall consists of epidermis, endothecium, one or two middle layers and a tapetal layer, The latter is of the secretory type and consists of uninucleate cells. A very large number of microspore-mother cells are produced per microsporangium. A large number of compound pollen grains are formed within a single microsporangium. Each compound grain consists of 4-8 pollen grains.

2. The ovules have two integuments and the micropyle is formed mostly by the outer integument. There is a single hypoder mal archesporial cell in the young ovule. The primary parietal cell undergoes divisions, so that the mother-cell comes to lie 3-5 layers deep in the nucellus. A linear tetrad of megaspores formed.

3. The chalazal megaspore develops into an embryo-sac which is of the normal 8-nucleate type. The antipodals form definite cells.

4. The primary endosperm nucleus divides by free nuclear division before the division of the oospore. The wall formation commences first at the periphery and then extends to the micropylar region. The chalazal region contains only free endosperm nuclei except for a layer of parietal cells for a long period.

5. The first division of the oospore is transverse and the second one is vertical. Later divisions are irregular and a spherical embryo is formed. It is of the massive type.

3. Massulae in the Genus *Salvinia.*

T. S. MAHABALE and JOYCE D'MELLO, (Bombay).

Massula is a unique structure formed within the developing microsporangia in the genera *Salvinia* and *Azolla* belonging to the Hydropteridiaeae.

In 1943, Sahni and Rao (*Proc. Nat. Acad. Sci.*, Vol. 13 (1) pp 48-50) gave an account of a fossil massula under the name *Massulities coelatus*, tentatively attributed to the genus *Salvinia,* which was hollow in the centre and had a spherical shape. On consulting previous literature on the genus it was found. that such a hollow massula was not known before in *Salvinia.* It was, therefore. thought worthwhile to investigate the structure of the massulae in three species of *Salvinia, Salvinia natans, Salvinia auriculata* and *Salvinia cucullata* growing in the Bombay gardens. It was found that there is a close correspondence between the adult massula of *Salvinia auriculata* and *Massulities coelatus,* both being hollow in the centre with microspores scattered at the periphery of the pseudocellular mass. This is not, however, the case in the other two species.

The central cavity in the massula of *Salvinia auriculata* is due to the progressive vacuolisation of the pseudocellular mass, which remains solid in the case of *Salvinia natans.* The massula in the third species, *Salvinia cucullata,* is entirely of a different type. Here the plasmodial mass contains a few or no vacuoles and the large and numerous nuclei in the tapetum persist throughout. No pseudocellular mass is formed here by the plasmodium and the mature spores are sacattered haphazardly in the midst of nucleated plasmodium. A few of the spores are degenerate.

Thus there are three types of massulae in the genus *Salvinia* of which the hollow type appears to be the most ancient one as it is found in the earliest known species of the genus namely from the Eocene period of the Deccan Intertrappeans.

4. Study of the Mangrove Vegetation—I: Leaf, (Epidermal Characters).

V. R. Rajagoplan, (Annamalainagar).

The mangrove at Pichavaram is constituted of *Rhizophora mucronta,* Lamk. (Rhizophoraceae), *Bruguiera caryophylloides,* Blume. (Rhizophoraceae), *Sonneratia apetala,* Buch.-Ham. (Sonneratiaceae), *Aegiceras majus,* Gaertn. (Myrsinaceae), *Lumnitzora racemosa,* Willd. (Combretaceae), *Avicennia officinalis,* Linn. (Verbenaceae), *Acanthus ilicifolius,* Linn. (Acanthaceae) and *Excoecaria agallocha,* Linn. (Euphorbiaceae). A close study of the epidermal characters of the leaves show a characteristic grouping of the constituents based on certain definite structures of the epidermis. They are (*a*) the general pattern of the epidermis is of a beautiful pattern of lattice work of various shapes and sizes of tabular cells in *Rhizophora, Bruguiera, Sonneratia, Lumnitzera, Aegiceras,* and *Avicconnia,* whereas the pattern of *Acanthus* and *Excoecaria* is markedly different; (*b*) on the other hand a study of the stomata based on subsidiary cells surrounding them show that *Rhizophora, Bruguiera,* and *Aegiceras* can be classed in a single compact group having 6 subsidiary cells; *Sonneratia* and *Lumnitzera* so far as the lower epidermal characters are concerned agree closely in the structure of their stomata with the three preceeding constituents. But by virtue of the fact that owing to the orientation of the leaf, they possess stomata (with variable number of subsidiary cells) on the upper epidermis also, they may be classed in a group by themselves. The subsidiary cells of *Avicennia, Acanthus* and *Excoecaria* are rather variable being 2 to 4, as such they fall in another group distinct from others.

It is interesting to note that *Excoecaria agallocha* grows even under normal terrestrical conditions miles away from the mangrove vegetation; *Acanthus ilicifolius* too has been found growing away from the mangroves but only in the fresh water marshes of the rivers. *Avicennia,* however, has been found in terrestrical condition in the halophytic areas along with *Suaeda* not more than a furlong away from the fringes of the mangroves. The correlation of the epidermal structure and habitat has been discussed in the full paper. It may be noticed that the facultative *Acanthus* and *Excoecaria* have structural differences much different from the other constituents both in the pattern of the epidermal cells and subsidiary cells round the stomata. Camera lucida sketches and micophotographs will be exhibited at the meeting.

5. Studies in the Morphology of Pollen Grains I—(Acaenthaceae).

A. T. NATARAJAN, (Annamalainagar).

A study of the shape and structure of the pollen grains of eleven species of Acanthaceae, mostly wild in the local flora, has been made. They are *Thunbergia grandiflora* Roxb., T. *Fragrans* Roxb., *Ruellia prostrata* Poir., *R. tuberosa* Linn, *Strobilanthus kunthianus* T & Anders., *Adathoda vasica* Nees., *Justicia gendarussa* Linn., *Asteracantha longifolio* Nees., *Cardanthera uliginosa* Buch. Ham., and *Barleria prionitis* Linn.

A detailed illustrated account is given in the fuller paper. A classification has been erected based on the present study and the same is detailed under:

Pollen grain: Exine Twisted:—*Thunbergia*
Pollen grain: Exine not twisted:
Body spherical:
Exine with reticulations and not pitted:
Regular:—*Acanthus*
Irregular:—
Well-defined:—*Barleria*
Not well-defined:—*Asteracantha*
Exine pitted:
With striations—*Cardanthera*
Without striations:
Germ Pores 2:—*Adhatoda*
Germ Pores 3:—*Justicia*

On comparision with the classifications of Hooker and Engler-Prantl, the present proposed classification falls in line with that of Engler-Prant (Lindau) except for *Barleria* whicch according to Lindau has been classed in *Contortae*. But on the observations based on pollen grains it should have been included in *Imbricatae*. The position of *Barleria* in the scheme of classification is discussed to show that it appears to be a genus comprising a plexus of characters of both *Contortae* and *Imbricatae*.

6. Systematics and Morpho-Biological Studies of Plants—I (Not-Weather Flora).

K. R. VENKATESAN, (Annamalainagar).

During the hot weather (June—July), the fields in the suburbs of Annamalainagar are clothed with a characteristic type of vegetation constituted mainly of the following species representing five families:

Chrosophora prostrata Dalz. *Chrozophora rottleri* Klotsch.	Euphorbiaceae
Polygonum plebejum R. Br.	Polygonaceae
Heliotropium ovalifolium Forsk. *Heliotropium supinum* Linn. *Coldenia procumbena* Linn.	Boraginaceae
Sphaeranthus indicus Linn.	Compositae
Cleome chelidonii Linn.	Capparidaceae

It is remarkable that they make their appearance during the last week of March and by the end of July or the first week of August, most of them finish off with their life cycles and they completely disappear from the flora. A complete description of each of the constituent species is given drawing attention to the important biological characters *e.g.* root system, lie of their branches, orientation of leaves and the protective hairs (trichomes and emergences).

A special study has been made of their epidermal hairs and emergences. They have been found to be so very specialised and characteristic in each species that it is possible to identify the hot-weather plants and several other which were found growing alongside in their association. From the structure of the hairs and emergences. An artificial classification based on the above study is given in the fuller paper.

7. Studies in the Hydrophytic Vegetation of South India—I.

C. LAKSHMANAN, (Annamalainagar).

The vegetation studied, comprising of about a dozen species, approxiately resembles Warming's Limnaea-type, classifiable into four distinct groups constituting distinct independent formations:

Group A: Plants jutting out above the water level. e.g. *Typha, Monochoria, Scirpus* and *Cyperus.*
Group B: Plants with floating leaves. e.g. *Nymphaea* (Red and white varieties).
Group C: Amphibious plants floating on water, e.g. *Neptunia,* and *Ipomoea.*
Group D: Plants constituting the submerged floor formation of the tank, e.g. *Najas, Ottelia* and *Hydrilla.*

Anatomical study has been made of the constituents enumerated in relation to their epidermal characters and stomatal and mesophyll structures. It has been found that in *Group A* there is a close agreement in their stomatal structure, namely, in each species, they are regularly surrounded by two subsidiary cells. In the internal anatomy of the leaves as well in this group there appears to be a good deal of homoplasy in structural details. Similar agreement in structural details within a group has, however, been found even in.

Group B: Having stomata with six subsidiary cells.
Group C: Having stomata with two subsidiary cells.
Group D: Exhibiting almost a complete absence of stomata.

A discussion is given in the fuller paper of the correlation of structural modifications of the leaves in relation to environmental factors.

Section IX. MEDICAL & VETERINARY SCIENCES

1. A Note on the Study of Certain factors in the Epidemiology of Malaria.

R. B. LAL, S. C. SEAL and L. M. BHATTACHERJI, (Calcutta).

A study of carrier species of mosquitoes in connection with the local malaria problem was undertaken in an area of moderate endemicity in the Hooghly district, about 40 miles from Calcutta on E.I.Railway, to find out the period of the year during which the transmission of the disease takes place and whether *A. philippinensis* was solely responsible, and to observe certain physical, chemical and biological factors which might influence its breeding habits. The observation was, however, limited to a period of 7 months from September 1947 to March 1948.

Ten species of Anopheline were found breeding in the area. 210 potential breeding places were under observation, in only 22% of which *A. philippinensis* was found breeding, the main breeding season being September to November. The physical and chemical characters as well as well as the biological fauna of these tanks have been studied. Some statistically significant differences were observed in the values obtained for temperature, pH, total solids, hardness, chlorides and, to a certain extent, albuminoid ammonia and dissolved oxygen, between tanks which showed *A. philippinensis* and those which did not.

Of the 2240 adult anophelines dissected 478 were *A. philippinensis*. But infection in the latter was detected upto December and no vector other than *A. philipinensis* was found infected. As a further evidence of transmission monthly examination of spleen and blood of infants and children were carried out, the same individual being followed as far as possible. Of the 93 infants kept under observation 25% gave evidence of first infection in September, 22.5% in October, 20.6% in November, 15.8% in December, 14.3% in January and 11.1% in February. Apparently the transmission took place more or less throughout the period between September and March the maximum amount occurring between September and November. These observations were supported by variation in the spleen and parasite rates in the population. All the three species of plasmodia were encountered in this area, *P. falciparum* being the predominant species (75%) during the period of highest transmission. *P. vivax* began to rise from January and was maximum in March when both these species were almost equally distributed. *P. malariae* was sporadic and was only found during the winter months.

2. Notes on the Bamboo flowering, migration of rats and their unusual mortality in certain districts of North Assam.

S. C. Seal, S. C. Ghosal & P. N. Bose, (Calcutta).

At the request of the Director of Health Services, Government of Assam, an investigating party consisting of the representatives from the Epidemiology and Microbiology Sections of the Institute was sent to the area in the first week of September 1948, to inquire into the cause of unusual mortality among rats in the Darrang District and North-Lakhimpur Sub-division of Assam. The main purpose of this investigation was to ascertain whether the deaths among the rodents were particularly due to plague infection. Although the party arrived a little too late for a thorough investigation it was, however, possible to exclude plague infection as the cause of rodent mortality. The story of the incident as far as could be elicited was briefly as follows:

"A large number of rats assembled and proliferated in the foot-hill areas of the Dafla Hills being attracted by the bamboo flowering which had been going on for the last one year and whose seeds formed their favourite food. In the normal course of events the rats disperse after the flowering season which comes off every 35-40 years. It is said that during this dispersal they often caused damage to the prevailing crops and some deaths among them were also noticed. But this year the circumstances which changed this normal course of events and caused a large number of deaths among them were: (1) Heavy rains throughout June, July and earlier part of August causing frequent flooding of the foot-hill areas; (2) shortage of food in the Dafla and Balipara Frontier tracts, helped further by flood and destruction of crops by rats. Three methods of deaths among the rats could be discovered viz., (1) drowning due to flood and while crossing the streams (2) violence by the local people and (3) possibly starvation and exhaustion. No known type of infection was detected by postmortem and bacteriological examinations and the question of plague infection could be completely eliminated. The interesting facts were—the bamboo-flowering and its relationship with the rat migration, *R. rattus* as a field rat and absence of fleas in the rats.

Section XI. PHYSIOLOGY

1. Some observations on the relation between the Blood Pressure and Intra-ocular Tension.

D. D. Sathaye, (Poona).

It is generally agreed that the pressure in the intra-ocular capillaries varies with the increase or decrease of general blood pressure and also that blood pressure in the intra-ocular arteries is higher than that in the chambers of the eye. When the pressure in the chambers is equal to 26 m.m. of Hg. then the pressure in the capillaries of the ciliary body is little higher than 50 m.m. of Hg. and pressure in the arteries is somewhere between 90 to 100 m.m. Intra-ocular tension in the eyes of 1202 persons were recorded though the number of eyes examined was 2,394 as 10 persons were blind by one eye. The following conclusions are based on the figures:

1. Normal intra-ocular tension varies from 19 to 25 m.m. of Hg. Only 8 out of 1202 persons had intra-ocular tension higher than 30 m.m. of Hg.
2. Women usually showed a higher tendency for intra-ocular tension.
3. Left eyes showed proportionately higher tension than right eyes.
4. In women, more than in men, high blood pressure is associated with higher intra-ocular tension.

2. Colon-Gastric Reflex.

S. N. Mathur, (Lucknow).

The phenomenon of Gastro-Colic Reflex in which the interior of stomach acts as a receptor organ at one end and the Colon as an effector organ at the other end of a reflex arc is well known. Some years ago it was shown by the author that pH of saliva varied with the pH of blood and could be utilized for determining the pH changes occuring in it during the predigestive, digestive and post digestive activities of the stomach. Change in the pH of saliva towards alklinity has now been regularly observed during defaceation. This has been found to be due to the acid secretion in the stomach. As the change in pH and act of defaceation occur almost simultaneously, and the fact that the act of defaceation quicken the digestive processes of stomach, it is certain that stomach is reflexly stimulated to increase its secretions which in their turn change the blood pH and consequently the pH of saliva. This appears to be the nature's way of increasing the digestive activities when Colon is empty, just as emptying of Colon is nature's way when fresh food enters the stomach.

3. A New Method of taking Alveolar Air Samples.

S. N. Mathur, (Lucknow).

The usual method of taking Alveolar air samples by means of Haldane's long tube, while satisfactory for ordinary purposes is not so when quick samples have to be taken for particular experiements. For example, samples may have to be taken, say, every two minutes, as part of the procedure for determining the pH changes occuring in the blood during feeding experiements. This difficulty can be solved by using mouth cavity itself in place of Haldane's tube. Just prior to the termination of a forcible expiration the nose is clipped, and the mouth shut tightly with the cheeks blown out by the extreme effort of the forcible expiration. One of the ends of an exhausted sampling tube is then slipped between the closed lips and the stop cork opened. This draws out the alveolar air which was enclosed in the mouth cavity. This procedure was found very satisfactory and convenient. By avoiding the tube chances of diluting the alveolar air are completely avoided.

4. Gelatin as a Transfusion Material in Experimental Haemorrhagic Shock.

M. DAMODARAN, E. K. NARAYANAN, GURDAS SINGH & M. B. GHARPURE, (Poona).

Gelatin prepared in the laboratory from the long bones of goats has been tranfused as a 6% heat sterilised aqueous solution in 5% glucose and 0.9% sodium chloride at pH 7.0, in amounts of 250 cc. in dogs, (average weight 12 kg.) and 75 cc. in cats (average weight 3 kg.) subjected to severe haemorrhagic shock (rapid depletion of about 50% blood volume) and compared with glucose saline. Observations have been made of the blood pressure and respiration of the animals from the beginning of the haemorrhage till 3 hours after the end of the transfusion or the death of the animal, whichever was earlier.

It has been observed that gelatin, unlike the crystalloids, maintains a large measure of the resuscitated blood pressure and helps the animal to survive the shock. No alarming respiratory disturbances have been noted. Some gradual lowering of blood pressure observed during the post-transfusion period was attributed to the diffusible nitrogen content of the gelatin. The work is being continued by extending observations to blood volume changes as well, with preparations of gelatin obtained by different methods of processing.

5. Studies on Vegetable milk prepared from Groundnut and Mixture of Groundnut and Soya Bean.

M. N. MOORJANI and V. SUBRAHMANYAN, (Mysore).

Metabolic studies with adult rats kept on cow's milk or groundnut milk fortified with clacium have shown that the percentage retention of injected calcium and phosphorus were 34.5 and 39.3. The respective figures for groundnut milk were 31.2 and 34.2. The biological value of proteins of milk prepared from germinated groundnut 75% and germinated soya bean 25% has been shown to be higher than the protein of milk prepared from groundnut. The protein of the vegetable milk was found to be 91.8% as efficient as casein for the purposes of haemoglobin regeneration and 70.2% with regard to R.B.C. formation. Vegetable milk protein is as good as casein in regard to the maintenance of total serum protein and albumen levels. The albumen-globulin in ratio of both vegetable and cow's milk protein remains the same. The comperative study of the supplementary relationship between proteins of cow's milk and vegetable milk supplemented to wheat flour has also been studied.

6. Biological evaluation of rice proteins by regeneration of liver protein in the rat.

M. R. SAHASRABUDHE and M. V. LAKSHMINARAYAN RAO, (Mysore).

Repletion of liver proteins in adult male rats receiving a diet containing 10% rice glutelin as the main source of protein for four days after 48 hours of fast was found to be 96.4 per cent that on a similar diet in which casein was the chief source of protein. On a dietary level of 5-6% there was practically no difference between casein and rice proteins in the efficiency for maintenance of liver proteins. The experiments have shown that rice proteins are not deficient in the amino acids specifically required for liver protein synthesis.

7. Methionine and cystine contents of rice proteins.

M. R. SAHASRABUDHE & M. V. LAKSHMINARAYAN RAO, (Mysore).

Rice glutelin is rich in both the sulphur containing amino acids. In this respect it is comparable to animal, fish and crustacean muscle-proteins.

8. Effect of Blending Hardened vegetable oils having high melting points (500 C or higher) with refined oil on the nature and Nutritive value of the resulting product.

M. R. SAHASRABUDHE & V. SUBRAHMANYAN, (Mysore).

Invitro and *In vivo* digestibilities of straight hydrogenated and blended fats of the same melting points has been studied. The fats showed the following decreasing order of hydrolysis:—Pure ghee, refined oil, blended vanaspati, straight hydrogenated oil, high melting hydrogenated oil.

Invitro digestibility showed no significant difference between the blended and straight hydrogenated preparations of the same melting point.

Chylomicrographic estimations on human subjects showed a considerable difference between blended and hydrogenated fats melting at temperatures higher than 47°, but practically no difference was observed at lower melting points.

Analyses of hydrogenated and blended groundnut oil showed generally a smaller percentage of linoleic and a greater percentage of stearic acid in the straight hydrogenated products than in the blends melting at the same temperature.

Section XII. PSYCHOLOGY & EDUCATIONAL SCIENCES

1. Statistical Study of Mental Disorders of 1172 Cases in a mental hospital.

ATUL BEHARI DUTTA, (Calcutta).

The paper reports about 1172 cases of patients treated in the indoor department of the hospital from 1935 to 1949 of which males were 852 and femeles were 320. The treatment is made according to Ayurvedic method. In making classification both Ayurvedic and Psychological and Etiological names of Western system are given side by side. In Maniac-Depressive Psychoses i.e., Bat-shlesmaja and Pitta-shlesmaja unmad there were 749 cases about 63'5 per cent of the total cases. In Schizophrenic Psychoses corresponding with Tridosaja unmad there were 246 psychotics out of 1172 making 21 per cent. In Paranoia group there were 79 cases being 3'7 per cent of the total cases. In Involutional melancholia there were 6 cases. In Alcoholic and Drug addiction there were 22 cases. In Hysterical psychoses there were 9 cases and in Epileptic psychoses there were 5. In Puerperal psychoses there were 15 cases. The cases generally suggested in producnng the various types of mental disorders are (1) Heredity, (2) Alcoholism, (3) Drug addiction, (4) Focal infection, (5) Physical disease other than infection, (6) Veneral Disease, (7) Trauma, (8) Age, Sex, Culture, (9) Puerperism, (10) Widowhood, (11) Stress and strain in life, (12) Other precipitating factors.

The number of insances in different provinces of India and in U.S.A. and England and Wales and Scotland with their ratios per lac of population are given.

Number of patients cured after treatment were 1122 out of total 1172 making 89·8 per cent.

GENERAL SYMPOSIUM ON ENGINEERING DEVELOPMENTS IN INDIA IN RELATION TO SOCIAL WELFARE.

HELD AT POONA ON TUESDAY THE 3RD JANUARY 1950
UNDER THE PRESIDENCY OF

Dr. D. R. Malhotra, D.Sc., F.N.I.*

President of the Engineering & Metallurgy Section.

I

ENGINEERING DEVELOPMENTS IN RELATION TO SOCIAL WELFARE IN INDIA

M. S. Thacker, M.I.E.E., F.Am.I.E.E.

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The natural resources of a country provide its wealth. The scientist and the engineer creates it, economist attempts to control its distribution. The standard of living in the present day world is directly dependent upon the intelligent and continued use and development of these resources. Science and engineering has a deeper meaning than the mere utilisation of resources or development. It is an instrument of social progress. History has shown that the great advances in literature, art and philosophy have been made by comparatively few people who have been provided, through the economic and social systems in which they lived, with the opportunity of devoting their time and energies to such advancements. In the early days this meant that many slaves were required for every scholar or member of the intelligensia who was not devoting his time to the process of earning his own living. Today scientific and engineering achievements are providing an equivalent of a large number of slaves for every man, woman and child, and in so doing it gives to all people the opportunities for an intellectual development that heretofore was restricted to very few. Engineering is not only necessary but it is also the key to technical, social and economic progress. This progress cannot be attributed entirely to the presence of natural resources. Such resources have been present for years. It has taken millions of years to bring them to human usefulnes. Science and technology, through the scientists and engineers, have largely contributed to the world problems, social and ecomonic, and to reach those mass populations. India faces today problems of vast magnitude in her development of her social and economic conditions in which science and engineering is of paramount importance.

We speak of over-production when we never had a decent general standard of living in this country; we speak of technological unemployment when it is on technology alone that we find our solutions for higher standard of the future; we speak of our investments when an adequate provision of goods and services to the mass of our fellow citizens require large and more efficient production facilities than we ever dreamed of. In India, to-day, the conditions are changing rapidly. Policies for national welfare are in need of guiding principles. Knowledge of probable scientific and technological trends is a great help; the material factors that shall determine the economic well-being of India are the development of her scientific and technological progress and economic organisation. In a country which is trying to achieve a rapid growth and which has hitherto remained under-developed, scientifically and technologically, the first requisite is its scientific and technological achievement and its social effects later. The significance of technology for social and economic life may be given by considering certain developments of the twentieth century. Only half the century out of the twentieth century has elapsed during which the world has experienced a phase of unparalleled development. A scanning of these technological developments would reveal the present material prosperity of the western countries.

What is India's main requirement today? Food. Hundreds of crores of rupees are melting away in buying this most essential commodity in the areas of hard currencies. India is an agricultural country and should be able to more than support herself. The other problems that are facing us are a good deal of unemployment and increasing of our productivity. This requires overall measures of increasing volume of goods and services produced in the country, and the volume of labour employed in the creation of national products.

Agriculture in India today is not an industry. Few industries are influenced by technological methods as agriculture. Because of the large variety of technologies which bear on agriculture, specialists in these fields have to contribute greatly to technological change in agriculture. The present day productivity of the average worker in agriculture is meagre. The methods of agriculture have to be studied. Mechanisation of agriculture have to be adopted to suit Indian conditions and will have to be arranged so as to depend for its general utilisation upon the economic and physical feasibility of the country and the people. Various problems here are involved where a scientist and an engineer has to give all his best in helping the expansion of farming into new lands suited to large scale methods of production, in increasing the farm labour efficiency, in giving them electricity, in providing refrigeration for farm and dairy produce, in the reclamation of arid lands, in providing better farm buildings, in irrigation, and in pumping, in plant breeding and improvement. It does not end here. The domestic farm animals represent millions of highly adaptable factors for food, fibre or power. Health and security are major objectives of the human race. Domestic animals and their products with the benefit or means of research and technology seem to offer increasing aid towards those objectives. The technology also bears a relation in regard to the farming in the study of its soil, its use and conservation, in chemical fertilisers.

Engineering in its social relation and uplift of the country, has also the task in front of it—to supply the mineral technology, to explore, investigate the supply of fuels and raw materials on which modern life has come to depend on the resources of the under-earth. The minerals have become the greatest of the raw materials of industry, the chief basis of chemical manufacture, the chief materials of construction. The scientist and the technologist have to give it the technique of exploration and technology in mining. Apart from the economic development depending on this, the technologist also to consider this in the defence of the country and bring his technology to bear towards some strategic minerals.

Kipling's assertion that transportation is civilisation, in India's planned development transportation is one of the most important factors for its economic and social life. There are questions of railway transportation, high-way transportation, waterborne transportation, and air transportation. The commercial air transportation is ideally suited to Indian conditions, on consideration of time and space and being primarily adopted to much longer distances than the average passenger journies. The social effects of a great and highly efficient transportation system today, in India, cannot be denied.

If not the most important, probably one of the most important reasons, for the progressing and widening of the individual human being's perception of the world around him has been the tremendous growth of communications. Radio telegraph, telephony, special communication channels are all a prelude to India's development in its relation to the social uplift. An engineer has to consider the tremendous implications which underline the balance between engineering developments and the social and economic trends in communication.

It has been said that electricity in modern life is second in importance only to food and shelter. In India, the present power development as compared to the other civilised countries is infinitesimal. India's great potentialities must be developeed soon. Civilised people of today are dependent upon power—power driven machinery for industries, power driven machinery for the furniture and furnishing of the homes, for clothes, for the materials which enter into building people's shelters, for systems of transportation, for modes of communication, in fact for all the material content of the present civilisation. The very food, drawn from farm, forest and stream, depends on systems depending upon power. Manufacturing, mining, communication, transportation and other fields of production activities have been advanced by power, shortening the time necessary to achieve the results.

The influence of science of chemistry and chemical engineering on all world trends becomes far greater when considered in its relation to social welfare. The products of the chemical industry are rarely recognised by the ultimate consumer as such because they do not reach him as individual products.

In all these technological developments there is the back-bone which is research and has to be recognised.

It is not only the above developments in which is bound up India's social and economic progress but other related parts where science and engineering has to perform its part—development of public health engineering, sanitation, water supplies, etc.

The future role science and engineering and the scientists and engineers in the social and economic building can no longer be ignored. The Indian development has to be carried out on the basis that would take advantage of the peculiarities of the people and of the country. The extent to which India's scientific and technological personnel can bear to bring their interest in encouraging and developing these means will largely determine in the next decade her development as a country of sound social and economic conditions.

II

RIVER CONSERVATION & CONTROL

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Primary source of water being rainfall, it is a renewable natural resource; but owing to its limited supply and faulty distribution, conservation and control of water are inherent in the problem of its utilisation. "River conservation and control", therefore, constitutes and essential social service. It is a very comprehensive subject embracing all the fields of water uses, irrigation and navigation, power, flood-control etc. The paper gives a brief review of the river conservation problem generally and deals with the flood control problem somewhat in detail as it is often neglected and as flood constitutes a major evil from which large mass of people suffer year after year.

2. Nature has her own methods for the conservation and control of rainfall as compensation against its erratic distribution by having the precipitation partly in the form of snow if there is any catchment area at sufficiently high altitude, and what is more important, by absorbing and storing underground a substantial portion of rainfall, thereby reducing the run-of and the intensity of floods and at same time providing a vast subsoil reservior which, by percolation through the soil, throughout the year, maintains the river flow when there is no rain and no surface flow to maintain it otherwise. The utility of a river to serve our various needs mainly depends on this compensating action provided by nature which again depends on the condition of the catchment, *i.e.*, whether it has sufficient area under vegetation, particularly deep forest, which retards run-off thereby reducing the intensity of floods and their silt-content and increases the portion of the rainfall which is absorbed and stored underground to maintain the river flow by subsoil percolation during the dry weather. It is interference with this natural economy by destruction of forests and by other harmful acts in the catchment areas and in the river channel is responsible for most of our river problems, particularly the flood problem. To meet our growing needs, we want regular supply of water but by our action, we are making the distribution of river flow, already faulty, still more irregular. This adversely affects all the fields of water uses and particularly aggravates the flood problem. Food conditions in India and some other countries are briefly reviewed in the paper pointing out the enormous damage that is being caused by devastating floods fairly frequently.

3. Apparently, there is some conflict between the needs of the river and those of man as with the growth of population certain amount of interference with nature's economy is unavoidable, as room has to be found for the growing population and their needs from the land including the forests, now rapidly increasing with the progress of of civilisation, have to be met. This cannot be stopped but the process should be rationalised. What is required is that with the aid of our advanced scientific knowledge, by intensive study and research, attempt should be made to effect a reconciliation between the above conflicting interests. Mere negative approach may not be sufficient having regard to our growing needs of water. Postive aid to nature's economy is also necessary by rational land management, contour trenching, bunding and terraced cultivation along the hill slopes, together with efficient preservation of existing forests and afforestation where possible etc., all with the object of reducing the rate of run-off and preventing soil erosion. Though necessary in the interest of the various forms of water uses, they are of particular importance as preventive measures against floods. They do not involve much of capital outlay but mainly require organizational effort including research and legislation. They also permit land building activities in deltaic areas which is essential in nature's economy and help in maintaining the drainage system. It should however be emphasized that isolated action in a section of the river is not sufficient but comprehensive planning for the river as a whole is necessary irrespective of political boundary.

4. Of the remedial measures against floods, the most common is the construction of marginal flood embankment. At best, it is only a temporary expedient as the silt factor complicates the problem. In the economy of nature the silt is intended to be carried with the flood spill so that it could raise and fertilise the land reduce silt content in the river channel to what its velocity could transport. Embankment interferes with

this economy, deteriorates the channel and raises the flood level. It causes progressive deterioration in the drainage system, in public health and productivity of the soil by cutting off beneficial flood spill. Nor can the flood embankments offer permanent solution of the flood-problem as breaches are unavoidable which cause even greater damage due to concentrated discharge than by gradual inundation. A few typical instances are given in the paper with regard to the evil effects of embankments in India and some other countries.

5. Of the other remedial measures against floods, the most important is by construction of flood-moderating reservoirs. Flood-moderating reservoirs, however, are not likely to be financially feasible unless combined with other revenue producing objectives such as irrigation, navigation and power in multipurpose river development projects. Fortunately these objectives are not conflicting but complementary. Development of the immense potential wealth of our rivers by multipurpose reservoir projects is essential for raising the economic standard of the people. It may be noted that possibility of utilisation of our river flow by diversion works alone is almost exhausted in India. For expansion of irrigation and navigation and for power, storage schemes designed on multipurpose basis are therefore essential. As most of our major rivers flow through more than one state, this raises a number of complicated problems regarding loss of land to be submerged by reservoirs, water right, equitable apportionment of the water which are to be solved to the satisfaction of all concerned, before any progress can be made. Lack of agreement among the riparian states in this respect has hitherto proved to be a major obstacle in the way of our pushing on with the river development projects and making the country self-sufficient in food.

6. It will appear from above that both for conservation and exploitation, the rivers should be treated as individual units irrespective of political boundary. But waterways having been included in the provincial legislative list in the 1935 Act the Centre did not have any constitutional power to ensure observance of this fundamental principle by legislation in case of interstates rivers. This defect is being remedied in the new constitution which should be followed by a comprehensive Waterways Bill removing all obstacles that now stand in the way of our river development projects. It is understood that this Bill will be introduced in Parliament soon after it meets under the new constitution. Some suggestions are offered for consideration in drafting the Bill.

7. As regards organizational requirement for optimum development of interstate rivers, it does not seem to be desirable to entrust responsibility for river conservation solely to individual states who are directly benefited by its exploitation. Having regard to the natural tendency to minimise and even ignore the adverse effect on the river so long as its exploitation brings in immediate benefit, nothing substantial will really be done if the initiative is left individually only to those states who are directly benefited by such exploitations. Though the ideal arrangement would appear to be to entrust this responsibility to the Centre it is not likely to work efficiently in practice as the task will be much too unwidely for a single organization, having regard to the large number of rivers to be conserved in this sub-continent. Besides, co-operation of the states, particularly the local knowledge of their technical staff appear to be essential. It is therefore suggested that Inter State River Commissions consisting of representatives of interested states and of the Centre with adequate statutory powers and resources should be formed ultimately, one for each of the major river basins, to undertake responsibility for conservation and, as regards initative, also of exploitation of rivers. In a large basin like that of the Ganga, it will also necessary to create regional authorities for execution and maintenance of important inter state schemes. The necessary co-ordination between the different regional authorities will have to be effected by the Main Basin Organization and as between contiguous Basin Organizations by the Centre through

the CWINC. Necessary provision should be made in the proposed Waterways Bill to enable the Union Government to constitute these Bodies with adequate powers and resources. With regard to the latter it is suggested that a cess should be levied on the fruits of exploitation of rivers (irrigation navigation and power) and placed at the disposal of the River Commission to finance the conservation measures.

8. Provision should also be made in the proposed Bill for quick settlement of interstate water disputes. This following principles are suggested for consideration and inclusion in the Bill. The Union Govt. should have powers to authorise construction of schemes considered necessary in the interest of social welfare and general progress of the country even inspite of the opposition of recalcitrant minorities subject, of course, to due regards being paid to the legitimate rights and obligations of the various riparian states concerned. These rights and obligations should be defined in the Bill in principle. For instance, apart from the right of prior appropriation which has to be conceded, right over the balance of water-resourse available in any particular river basin should be governed by the needs of the various riparian states and the possibility should include (*a*) rational treatment of the catchment basin under the general control of, and, perhaps with a subsidy from the Main Basin Organization referred to above. (*b*) general control by this Body, as regards broad outlines only, of schemes initiated by any state which involves extraction of substantial quantity of water from the river and (*c*) finally, as regards inter state river development schemes, giving due facilities for their investigation, execution and maintenance.

9. To prevent sabotaging of promising schemes indirectly by any state, the proposed Bill should also lay down definite principles to regulate land compensation and rehabilitation. For this purpose, provision in the L. A. Act (I of 1894) should form the basis of compensation subject to the right of appeal to the Federal Court. Some concessions within reasonable limits seem justified for rehabilitaing large numbers of displaced population in the case of reservoir schemes. In this connection, the Engineer also has an obligation to reduce the area of permanent submersion by the reservior to the minimum extent possible, particularly as regards cultivated and culturable waste lands. Loss of food by permanent submersion of cultivated land in the interest of irrigation and flood control can certainly be justified as the acute food shortage in the country, large additions to this submersion in the interest of power alone can hardly be justified. Production of hydel power is certainly necessary but in the interest of our food economy, loss of cultivated and culturable land should be avoided as much as possible as making the country self-sufficient as regards food should be given the topmost priority in all our activities. A further suggestion to reduce the number of displaced population is that, provided the local condition is favourable, the extent of acquisition within the reservoir area may be limited to full supply level, with perhaps a little margin, as the higher land which will be submerged only temporarily for a few hours at a time during the passage of floods is not likely to suffer any material damage but may even benefit by occasional flushing with silt-laden floods. The homesteads will of course have to be shifted and houses re-erected on higher ground close by above the designed flood level, at the cost of the project.

10. Subject to the above remarks, the people who will have to be unavoidably displaced by the reservoirs should have the right to demand rehabilitation at the cost of the project in lieu of cash compensation. But subject to their present economic standard not being lowered which should be treated as the minuimum, standard of rehabilitation should be so fixed that the cost may not materially exceed the money compensation as assessed under the L. A. Act. If any state wants a higher standard being fixed for rehabilitation as a part of general rural uplift, it should be prepared to bear the extra cost.

III

THE DAMODAR VALLEY PROJECT IN RELATION TO NATIONAL WELFARE

B. C. GUHA, D.Sc., Ph.D., F.N.I.

Member, Damodar Valley Corporation

The Damodar Valley Corporation was set up by the Government of India under the Damodar Valley Corporation Act passed by the Central Legislature in 1948. The Corporation formally came into existence on the 7th July 1948. The function of the Corporation is to promote the multipurpose development of the Damoder Valley, which covers parts of the provinces of West Bengal and Bihar. It is expected to work on lines somewhat similar to those of the Tennessee Valley Authority. The Damodar Valley Project which the Corporation has been asked to execute consists of the buildings of a number ot dams in the upper Damodar Valley and the construction of a barrage in the lower valley in order to irrigate about a million acres of fertile alluvial soil of West Bengal. There will be a canal from the barrage to the river Hooghly which will be pernnially navigable and from which the distributory channels will spread out for the irrigation of the surrounding area. It has been estimated that the additional annual production of rice as a result of the Project would be of the order of 200,000 tons. Besides, during the rest of the year other crops like potatoes, pulses, wheat etc. could be grown. The installed capacity of hydro-electric power at the different dams would be 200,000 KW and this will be backed by firm power obtained from a thermal power station of 200,000 KW capacity which is being set up in the valley. The production of power from coat in the valley is particularly economic as the valley contains over 80% of the total coal reserves of India and the thermal power station can utilise the lowgrade coal which is remaining unused. This will be the first power station in India running on boilers using pulverised coal and working at 800 lbs pressure. A subsidiary benefit from the Project would be the development of Fisheries in the large reservioirs of water and also in the cannel and distributory channels. The scheme will also afford protection from recurring floods for which the river Damodar has earned a bad reputation for a long number of years. In fact the necessary of flood-prevention was the starting point for the project.

Soil conservation is a very important part of the project. A large portion of the Upper Valley is highly eroded. Steps have been taken to stop this erosion. This is both for rehabilitating the soil and for preventing the silting up of the reservoirs too quickly.

The Damodar Valley contains a very large number of important minerals apart from coal and an intensive survey of these minerals is now going on. It is expected that when the supply of power and water is ensured by the execution of the project there will be large-scale industrial development in the valley. The production of aluminium, phosphatic fertilisers, refractories, high tension insulators, etc, is envisaged, starting from the raw materials which are available in the valley and its adjacent areas.

IV.

There was a lively discussion on the points brought out in the papers of Mr. S. C. Majumdar and Dr. B. C. Guha (at the symposium), in which Mr. S. Trone (of U.S.A.), Mr. C. S. Ghosh (of Bangalore), Mr. B. Roy (of Calcutta) and Dr. Malhotra (President), participated.

The Convenor then gave an account of the views of the Sub-Committee on Science and Its Social Relations as regards the questions referred to it by the International Council of Scientific Unions. While expounding the views of the Sub-Committee the Convener mentioned about the terms of the Declaration Containing the Principles of a Charter for Scientists. The aforesaid Declaration and the views of the Sub-Committee are given below as a part of the proceedings of the symposium.

V

A SHORT ACCOUNT OF A DECLARATION CONTAINING THE PRINCIPLES OF A CHARTER FOR SCIENTISTS

By J. M. Sen, *B.Sc.*, M.Ed., F.N.I.

Convener of the Sub-Committee on Science and Its Social Relations of the Indian Science Congress Association.

The Committee on Science and its Social Relations instituted by the International Council of Scientific Unions, at its meeting held at the UNESCO House, Paris, on the 15th & 16th June, 1948, had drawn up certain principles of a Charter for Scientists which could be summarised as follows:—

"The prominent position held at present by science in society, and the rapid transformation of the world through the application of science, carry with them for scientific workers special obligations over and above the ordinary duties of citizenship. Besides this the scientific worker has special responsibilities since he or she has the possibility of obtaining information not readily available to the average citizen. It thus becomes the duty of the scientist to:

(*a*) maintain a spirit of frankness, honesty, integrity and co-operation, and to work for international understanding;

(*b*) consciously examine the measuring and purposes of the work that he or she is performing;

(*c*) when in the service of others enquire into the purpose for which the work is being done and the moral issues that may be involved;

(*d*) promote the development of science in the way most beneficial to mankind and exert his or her influence as far as possible to prevent its misuse;

(*e*) assist in the education of the people and the Government in the purposes and achievements of science.

In order to fulfil these obligations it is necessary to claim certain rights for scientists, the principle ones of which are:

(*i*) freedom of publications and the utmost freedom to discuss ones's work with other scientists;

(*ii*) economic security and the right to participate freely in all activities permitted to all citizens; and

(*iii*) the possibility of obtaining information about the purposes for which his or her work is being done."

The Committee on Science and its Social Relations has also undertaken an enquiry on the importance of Science and of scientific co-operation for peace. The aforesaid Committee has invited the opinion of the Indian Science Congress Sub-Committee on Science and its Social Relations on the following two main question:—

(*i*) In which measure do the methods of international scientific work contribute to the creation of an international spirit and to the maintenance of peace?

(*ii*) In which ways could scientific organisations and scientists intensify their activities for the maintenance of peace?

The aforesaid Committee has also raised the question of giving attention to *man* himself as the fundamental unit of Society and therefore has asked everybody to consider three principal aspects of social relations of science, *viz.*—(*i*) The scientist before society; (*ii*) The changes introduced in human societies through the technological development of science; (*iii*) The antagonism between biological order and social order.

A careful consideration of all the above questions was necessary for the future welfare of India. The solution of the problem is no doubt difficult but thinkers all over the world are trying to tackle it. An editional in the Journal of the Indian Chemical Society (Vol. XI, Nos. 1 & 2, 1948) under the heading 'Role of Scientists in the Control of Atomic Energy' urged that the scientists and technicians, while enlisting themselves as members of an international federation, should take an oath, in the words of Welfish as follows:—

> "I pledge myself that I will use my knowledge for the good of humanity against the destructive forces of the world and the ruthless intent of men, and that I will work together with my fellow scientists of whatever nation, creed or colour for these our common ends."

At a meeting of the Sub-Committee on Science and its Social Relations of the Indian Science Congress, Association held at Allahabad on the 3rd January 1949, it was resolved that the two main questions raised by the Committee on Science and its Social Relations instituted by the Internatonal Council of Scientific Unions should be carefully studied by the members of the sub-committee and the results of such study should be collated and communicated to the Indian Science Congress. After collecting the opinions of the members of the sub-committee they were summarised and placed before a formal meeting of the Sub-Committee on Science and its Social Relations, held at Calcutta on the 14th September 1949, when the following answers to the questions were recorded as the collective views of the Sub-Committee and communicated to the Executive Committee of the Indian Science Congress Association.

Q. I. *In which measure do the methods of international scientific works contribute to the creation of an international spirit and to the maintenance of peace?*

Views of the Sub-Committee.

(*i*) All genunine scientific work tends to create international spirit and helps in the maintenance of peace. It is only when military strategy on the employment of science to purely military ends requiring extreme secrecy is demanded from science that international amity is endangered. This being the case no new methods of international scientific work can help, save by the removal of these new factors. Restoration of free and unfettered exchange of information should be the aim of all scientists.

(*ii*) Anyone whose reading of scientific literature leads him to consult the results of work in other countries must realise that the fundamental methods of scientific thought are common ground to all nations. There may be something of a national type in the genius of institutional perception of a possible line of solution to a problem, but the methods of scientific demonstration and verification of a solution are of necessity the same the whole world over.

(*iii*) Anyone who realises this fact, even from reading (in original or in translation) the work of scientists in other countries, is brought to a fuller appreciation of what he has in common with men of other nations, and this must certainly contribute towards removing that part of the tendency towards conflict which arises primarily from fear of the unknown. When a scientific worker has occasion not merely to read the work of a foreign scientist, but also to exchange views with him as a colleague, there is a greatly increased probability of his appreciating the extent to which cooperation between individuals may be quite irrespective of nationality, and this attitude—which enters at the emotional level—cannot but help to contribute towards the maintenance of peace.

(*iv*) The general probability is that such benefits will be most fully forthcoming in the sphere of fundamental or abstract scientific work, where the issue will not be clouded by secondary considerations of how the application of the knowledge might put one or the other nation at a relative advantage. There are nevertheless, many fields of applied science where disadvantages do not come into the question—notably such sciences as tend to raise general standards of living—and international cooperation in these is bound to be fruitful in promoting fellow-feeling and a realisation of the benefits to be derived from the maximum development of international cooperation.

(*v*) If international laboratories are established in different parts of the world, it will go a long way in establishing closer relationship between workers of different nationalities and thereby creating an international spirit which will help in the maintenance of peace.

(*vi*) Meeting of international bodies should be help in rotation in different parts of the world thereby affording opportunities of closer contact between workers of different nationalities.

Q. II. *In which ways could scientific organisations and scientists intensify their activities for the maintenance of peace?*

Views of the Sub-Committee.

(*i*) Scientific organisations and individual scientists have hardly any voice in the political and military set-up of nations. The scientists are merely used as tools for furthering ends of politicians and military strategists.

(*ii*) There would seem to be three main lines along which science could hope to work positively towards the maintenance of peace, *viz.*,

(*a*) To demonstrate the benefits obtainable from a general continuance of peace; or complementary to this, to demonstrate the overall loss that inevitably results from war.

(*b*) To encourage the spread of scientific methods of thought in matters—particularly political matters—in which frequently emotion rather than reason plays a major part; so that policies may be founded upon facts and scientific principles as far as these can be ascertained, with emotion entering as the necessary inspiration towards effort rather than as a controlling urge blind to unpalateable facts.

(*c*) To find out the fundamental causes which lead nations to come war as a solution of their problems, rather than solving them by other means; and to find out whether there is any means of influencing these factors in a direction more favourable for peace. This is a matter on which psychology should eventually be able to give some guidance.

(*iii*) One of the causes of war appears to be a struggle for control of raw materials available in different parts of the world. Scientific organisations and scientists by their methods of investigation can find substitutes for raw materials which are now available only a particular country or region, or can create good products from low grade materials which are available in the country, and thereby remove one of the causes of war.

(*iv*) There should be central organizations, like the Rome Institute of Agriculture where literature of different countries on different subjects is summarized, and useful notes are prepared for circulation to different parts of the world. The staff of such a Central Institute should have representatives of different countries. The Central Institute should offer scholarships for studies in different subjects in different institutes of the world to students of all nationalities.

I

SYLLABI IN MATHEMATICS IN THE INDIAN UNIVERSITIES

Section of Mathematics

N. M. Basu, Aligarh.

A discussion on the above subject was held in the Section of Mathematics from 3 to 4 P.M. on the 4th January, 1950. In the absence of Professor B. N. Prasad who was to have opened the discussion, it was initiated by Professor N. M. Basu, President of the Section. He said that the syllabuses obtaining in most of the Indian Universities at the present time, besides suffering from a lack of uniformity of standard, were somewhat outmoded and had not kept up with the progress of Mathematics during the last forty years. Modern subjects like Topology, Modern Algebra, Theory of sets, Functional Calculus, Quantum Mechanics, Wave Mechanies etc. had hardly any place in the syllabuses of any university and students of mathematics, even after taking a good master's degree hardly knew what these subjects dealt with. This state of affairs was due to various reasons. At the present time the Syllabus in Mathematics for the matriculation examination of Indian universities was rather low compared to that of western universities. Professor Basu thought there was considerable room for the improvement of the standard of the matriculation syllabus by eliminating certain things which appeared to be unnecessary and introducing a few things now included in the syalabus of the Intermediate Examination. This would provide a little broader base for the imparting of instruction in higher mathematics at later stages. He did not however like to dilate more on this point as he had already touched this point in his Presidential Address. Secondly in many of the Universities there was either no provision for an Honours Course, or if there was a provision, either it was not a properly balanced course or it was only in name. It was essential for the proper progress of mathematical studies that there should be a properly organised Honours Course, preferably of three years' duration, to which only those endowed with real zeal and aptitude for mathematics should be admitted; and only Honours graduates should be permitted to take up the master's degree course in Mathematics. In support of his contention Professor Basu pointed out that generally speaking the South-Indian Universities had produced more mathematicians of distinction than North-Indian ones and this, in his opinion, was due to the fact that the South-Indian Universities had a better planned and more rational Honours Course in Mathematics than the others. At the present time M.A. and M.Sc. classes in mathematics in most universities were open to ordinary pass graduates who, by the nature of the courses for the pass degrees, were very inadequately equipped and unfit for pursuing mathematical studies of a sufficiently high standard and the result was that the syllabuses of the course for the master's degree had to be determined by the previous knowledge of these students and could not therefore be of the right standard. Futher, in some universities the course for the pass degree contained little of applied mathematics while in others there were two separate courses, one in pure and another in applied and a student was allowed to take either. Thus pass graduates who joined the postgraduate classes sometimes knew nothing of applied mathematics and therefore in those universities where there was only one mixed course for the master's degree, the standard in both pure and applied mathematics had to be kept rather low-in practice if not on paper for the benefit of the pass graduates. And where there were separate courses in pure and applied mathematics, the students who took the pure course would not, in some cases, know anything of applied mathematics and those who took the applied mathematics course would not have sufficient knowledge of pure mathematics. This was most undesirable for these two branches were so inter-related that no one who aspired to be a good mathematician could afford to do without an adequate knowledge of the basic subjects in both branches. Hence, Professor Basu emphasised once again, it was almost indispensably necessary that a course for the master's degree should be based on a strong Honours course which would demand a thorough acquaintance with the fundamentals of both pure and applied mathematies. It was only in that case that proper syllabuses could be framed. It was sometimes pointed out that some universities (Allahabad, for instance) had to discard the Honours' course as it did not prove attractive. This, Professor Basu thought, was a wrong and ill-advised step. The Honours course did not prove a success probably for the reason that the master's course was open to pass graduates as well and students wanted to follow the path of least resistance. In Professor Basu's opinion one definite policy should be pursued by all the universities, at least by all those in one and the same province, and that policy should be that no one who was not an Honours graduate in mathematics should be permitted to take the mater's degree course in mathematics. Further the course for the Honours degree should be more or less the same in all the universities at least so far as the basic subjects were concerned. Unless the universities co-operated in adopting a common policy in this matter there was, Professor Basu maintained, no hope for any improvements either in the standards which were very low at present or in the syllabuses which were old, out-fashioned and unsatisfactory.

After the opening remarks by Propessor Basu, the discussion was further continued by Professor C. Racine, Professor N. G. Shabde, Mr. Nagabhushanam and others.

CLOUD PARTICLES

Section of Physics.

DR. S. K. BANERJI, Opened the discussion.

In a symposium on "cloud particles", held at Poona on January 4, 1950 during the session of the Indian Science Congress, which was opened by Dr. S. K. Banerji and in which a number of scientists took active part, Dr. Banerjee made abundantly clear that much work still remains to be done for a fuller understanding of the manner in which cloud particles grow into rain-drops under the different conditions of evolution of clouds.

It has long been known from the investigations of Coulier, Mascart, J. J. Thomson, C. T. R. Wilson and others that the invisible water vapour which is always present in varying amounts in the atmosphere can change to the state of liquid only when there are nuclei present on which condensation can take place. When the humid air is cooled below the saturation point by radiation, or by mixing of warm and cold air, or what is more common by adiabatic expansion in ascending currents of air, the vapour condenses on the nuclei forming cloud particles. Different kinds of nuclei have been identified; the main effects of these different kinds are that for the formation of cloud particles on them, we require different degrees of super-saturation.

From the stage of cloud particles (of average diametor 7×10^{-4} cm.) to the stage of rain-drops (of average diameter 7×10^{-2} cm.), there is an increase of 10^6 times (or one million times) in the volume of each particle. Such a growth must involve continued condensation and|or coalescence of cloud particles. It is quite usual to see clouds overhead for hours without a drop of rain, and so it is not always that this process of growth is in operation. On the other hand, there are clouds, such as cumulus clouds, in which rapid formation of rain-drops occur. The circumstances under which this takes place has been the subject of investigation by a number of workers in recent years.

Measurements of sizes of cloud particles by Köhler, Kabraji, Schuman and others in clouds and fogs have shown that the frequency distribution can be expressed in the form of a curve as given below:

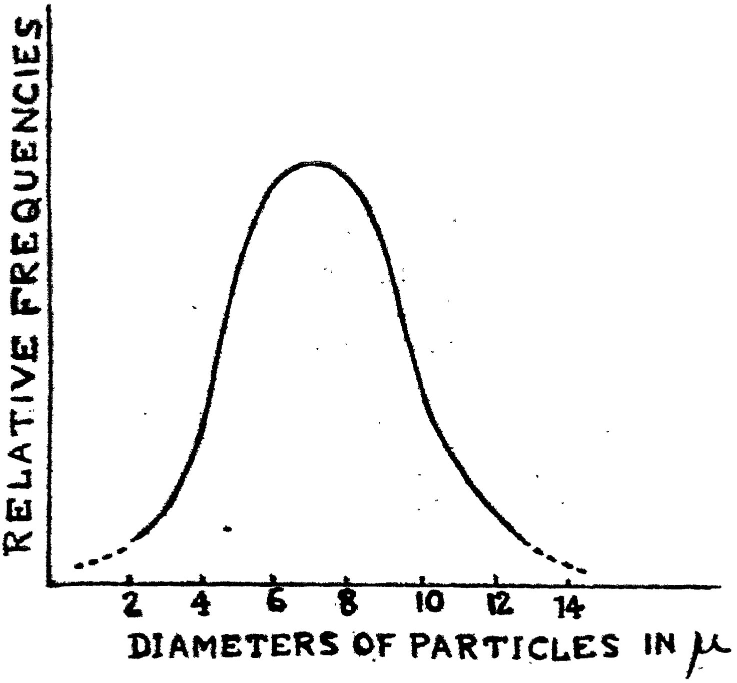
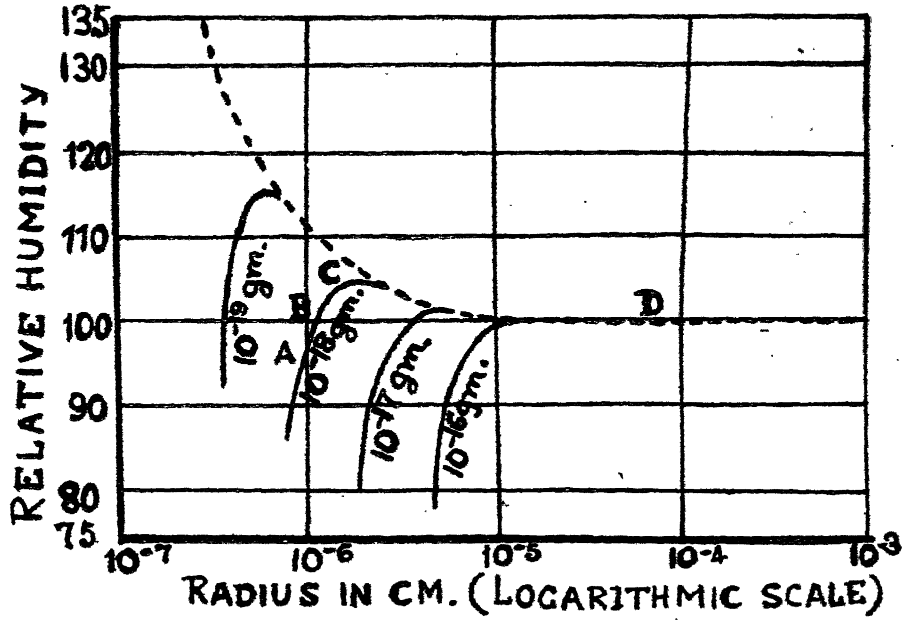


Fig. I.

In any sample, particles of different sizes are to be found, although a particular size may predominate.

The Evaporation—Condensation Theory.

In consequence of the effect of surface tension, small droplets in clouds have slightly higher vapour pressure than the larger droplets. The smaller drops thus evaporate to give vapour which condenses on the larger drops. This effect is illustrated in fig. 2.



COMPUTED RELATIVE HUMIDITY AT 0°C FOR DR
FORMED ON NaCL NUCLEI OF GIVEN WEIGHT

Fig. 2.

If we start with a nucleus containing 10^{-18} gm. of NaCl, it will have a diameter of .01 micron and be in equilibrium in a relative humidity of 95 per cent as represented by the point A. If the relative humidity increases, the drop will grow by condensation, the change in diameter with change in relative humidity being represented by the curve ABCD. At the point B, 100 per cent relative humidity is reached. Here the depression of the relative humidity due to concentration is equal to the increased humidity relative to the curvature. Beyond C the curve slopes downwards. This means that if the relative humidity is maintained constant (*i.e.* if the supersaturation is maintained), the drop will grow indefinitely. This is very important in determining the rate of growth of cloud particles within the first few minutes after they are formed. But after the droplets have grown to 30 or 40 microns, this process proceed extremely slowly.

If two drops are of the same size, and if there is a difference of temperature between the two, the vapour pressure will be more over the warmer drop than over the colder drop, and the colder drop will grow at the expense of the warmer drop. Since the vapur pressure curve rises abruptly for temperature above 5°C, (see fig. 3) this process will be effective even if the difference of temperature be small, say, of the order of 1°C.

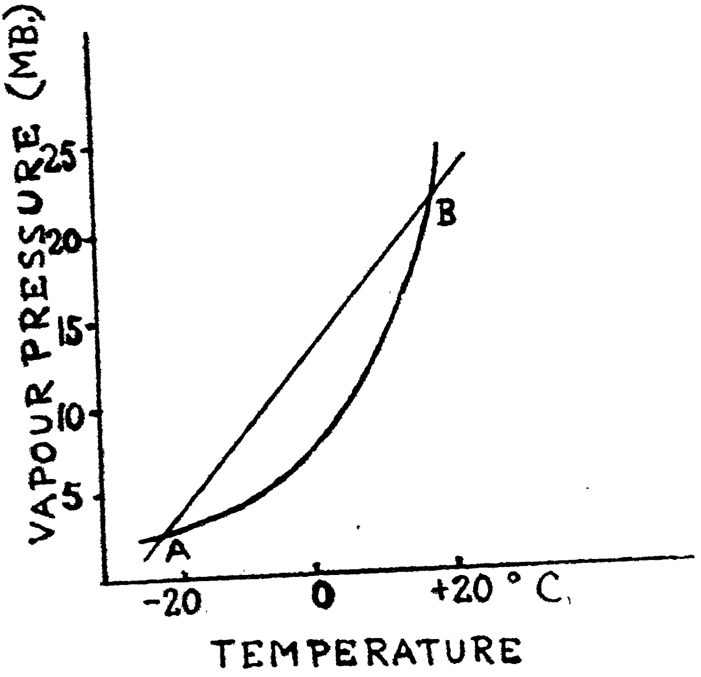


Fig. 3.

It is known that an electrical charge reduces the vapour pressure over a drop; a charged nucleus will, therefore, require less supersaturation for condensation than an uncharged one, but the effect of the charge decreases rapidly as the drop increases in size. With nuclei greater than $d = 10^{-7}$ cm. no charge which can be given to a nucleus reduces the relative humidity required for condensation by more than a fraction of one per cent. As atmospheric nuclei have diameters greater than 10^{-7} cm., electric charge does not appear to play an important role in the condensation of water on them.

Other processes in operation—mixture of ice and water particles.

Findeisen has derived a formula which shows that the distance travelled by a drop in the atmosphere, which is not completely saturated varies as $(\text{radius})^4$ and gives the following table.

Pressure 900 mb., temperature + 5°C, relative humidity 90%.

Radius of drop (cm.)	Distance of fall before evaporation.	
10^{-4}	3.3×10^{-4} cm.	cloud particles.
10^{-3}	3.3 cm.	
10^{-2}	150 metres.	
10^{-1}	42 km.	rain drops.
2.5×10^{-1}	280 km.	

It will be seen that for sizes less than 10^{-2} cm., the drops eveporate within 150 m. of descent and therefore cannot reach the ground through the unsaturated atmosphere, while a drop of radius 10^{-1} cm. (1 mm.) would certainly reach the ground. A cloud particle must grow to a diameter of 2×10^{-2} cm. before it becomes a rain-drop.

It was the general belief some years ago that the cloud particle grows by continued condensation and coagulation with other drops, while falling until it became sufficiently large to fall as a rain-drop. But many, which include Sir Napier Shaw, had doubts at to the amount of coagulation that could take place between cloud particles, owing to surface tension. Bergeron in 1933 threw doubt on the sufficiency of old ideas and suggested that some other factor beyond condensation and coagulation was necessary for precipitation. His arguments were that a cloud was a colloidal suspension of water in air, an 'aerosol' which will remain in this state of colloidal equilibrium until a sort of coagulation is released within it. Observations show that cloud particles tend to remain liquid down to temperatures of about -10°C; at lower temperatures, ice crystals appear amongst the water particles. These few crystals are in an atmosphere maintained at a relative humidity of 100 per cent relative to the water by water drops; they are therefore in a super-saturated atmosphere relative to ice. The supersaturation is 10 per cent at -10°C, 20 per cent at -20°C. Rapid sublimation into the ice-crystals must therefore take place, resulting in a rapid growth of the ice-crystals at the expense of the water drops. Bergeron makes a rough calculation of the rate at which a cloud of water drops would change into a cloud of ice-crystals, assuming that there is one ice-crystal to every eight cloud particles, and finds that the change would be effected in about 10-20 minutes.

Yet there are many clouds composed entirely of water particles which give copious rain. Findeisen has worked out the time taken for a cloud drop to grow to different sizes by the process of condensation and gives the following results—

	Diameter of drop (cm.)	Time to grow.
Cloud particles	2×10^{-4}	1 sec.
	6×10^{-4}	9 sec.
	2×10^{-3}	100 sec.
	2×10^{-3}	14 min.
Rain drops	2×10^{-2}	1.9 hr.
	2×10^{-2}	10 hr.
	2×10^{-1}	54 hr.

Therefore large rain-drops cannot be formed by condensation alone.

Findeisen then develops the mathematical theory of coagulation in a cloud due to the relative rates of fall of different sizes and then works out a numerical example for layer clouds. The results show that drops of size 2×10^{-2} cm. would fall from a cloud of about 200 m. thick, 8×10^{-2} cm. from a cloud 1000 m. thick and 14 x 10- cm. from a cloud 2000 m. thick.

In view of the intrinsic importance of this question, Langmuir, in a paper in the American Journal of Meteorology (October, 1948) has developed a theory for the efficiency of accretion process after taking due account of the trajectories of the small droplets moving near the surface of the larger falling drops. He reverted to the theory that some droplets in the cloud, which happened to be more than the average size, would fall more rapidly and so would overtake the others and coalesce with them. This growth by accretion will proceed at first slowly, but the rate of growth would increase rapidly as the drops acquired higher velocities and cross sections. The following equation was thus obtained,

$t = 18\eta / Egwr_0$

where η = molecular viscosity of air,

E = the collection efficiency,

g = acceleration due to gravity,

w = the liquid water content of the cloud,

r_0 = the initial radius of drop which started falling at time t = 0.

Equations were obtained for the growth of cloud droplets in a cloud in which the air is rising with a given velocity.

Certain critical conditions have to be satisfied so that droplets coalesce and not bounce off.

If U be the wind velocity, r the radius of the droplet, λs the range of the droplet, and *Ps* its density then $\lambda s = \frac{2}{9} \rho s \; r^2 U / n$. Denoting K as the ratio of λs to the radius s of a spherical collector, $K = \lambda s / s = \frac{2}{9} \rho s r^2 U / s n$

The critical condition for which cloud droplets first begin to reach the surface of the sphere is obtained by putting $K = \frac{1}{12}$.

The following table gives the collection efficiency for higher values of K.

	Limiting values of collection efficiency.	
K = ns|s	Aerodynamic flow.	Viscosity flow.
0.0833	0	0
0.10	0.011	0
1.00	0.445	0
1.5	0.563	0.060
10	0.907	0.634
100	0.990	0.924

A cloud layer 1000 m. thick with a liquid water content of 1 gm^{-3} ($w = 10^{-6}$ g cm^{-3}) will give a rainfall contributon of w = 0.1 *cm*. A40 μ drop would have to fall 13,000 m. through such a cloud before it would grow to 3000 μ.

Chain Reaction.

It would appear that in clouds formed in an air-stream with vertical ascent, a chain reaction may set in. What is meant by Chain Reaction? It merely means that each drop must give rise to at least 2 drops, the 2 drops to 4 drops and so on. Such a process can conceivably be set up by a falling drop growing to size of 0.5 cm. when it becomes unstable and breaks into 2 or more drops. These are carried up by the vertical current, grows again, and each one breaks into 2 or more drops. Starting with a certain number of large drops, a chain reaction may rapidly set up in this way. Arguments have been advanced by Langmuir that a chain reaction of this nature is started when "cumulus" clouds are seeded by pellets of solid carbon-dioxide.

Self-propagating action.

Findeisen has reported that during either sublimation of water vapour on to a growing ice-crystal, or the evaporation of an ice-crystal "ice-forming" nuclei (splinters) were formed in the surrounding air. Similar nuclei were also formed when water drops forze. Such a process in a super-cooled water cloud, would be a self-propagating action, and only a few initial ice-forming nuclei would be required to start it.

Further work.

While much work has been done in understanding the process which comes into play in the growth of cloud drop to a rain drop, it does not appear that all the phases in this process have been fully explained. The order of the differences of temperature between a falling drop and the existing drops in a particular layer is unknown, and how far the temperature difference will lead to growth of drops is difficult to estimate. In the accretion-process too, the efficiency may be increased on account of difference in temperature. The ratio of the diameter of the falling drop and the colliding drops must also be a determining factor in the accretion process. Mr. P. K. Das has a paper on this aspect of the case.

ELECTROLYTIC ALLOYS AND THEIR DEPOSITION

Section of Chemistry

Dr. T. Banerjee, Calcutta.

After the deposition of brass in 1941 by de Roults, much work has been done on the deposition of alloys. These alloys have been deposited mainly for the following purposes (one alloy often serving more than one purpose).

(*a*) Decorative *e.g.* α-brass, gold alloys, bright nickel etc.
(*b*) Protective *e.g.* Zn—Cd alloys.
(*c*) Engineering alloys—Bearing alloys and other alloys with special properties *e.g.* α —brass for rubber adhesion.
(*d*) Alloys of scientific interest but of limited uses at present.

Alloys have been mainly deposited with a view to industrial application and the ability to get desired colour has been the prior aim. As a result the alloys were deposited practically empirically. Even where deposition of fixed composition was aimed at, empirical processes were worked out only by trial and error, resulting in the accumulation of a large amount of controversial literature.

In the deposition of an alloy especially on an *indifferent* (Fremde) electrode (a necessary condition in plating), the composition of the alloys, deposited at constant current density, was found to change with period of deposition. All attempts to deposit alloys of constant composition by electrolysis at constant current density resulted in failure. Banerjee has however found that the composition of an alloy deposited from an electrolyte of which the concentration remains essentially unchanged during the period of electrolysis, is determined by the cathode potential employed and if the latter is kept constant, remains unaffected by the duration of electrolysis. He further observed with some binary systems, that rate of variation of the composition of the plate with change in cathode potential is influenced by the initial metal ratio of the bath. In some cases these variations have been found to be very small. So, if we can once decide a favourable composition of the bath electrolyte for the deposition of an alloy of certain composition range (where variation of the composition of the plate with cathode potential will be small), we can think of its deposition without requiring much attention of the platers and hence of its use in industries.

The structure of these alloys, though having a fixed composition depending on the constant cathode potential used, may or may not correspond to the phases, as demanded by thermal equilibrium condition. With brass in most cases the equilibrium phases were obtained but this was not the case with Ag—Cd alloys. These metastable phases, after being annealed at a moderate temperature for some time were however found to be converted into the equilibrium phases, corresponding to their respective compositions a point to be borne in mind while doctoring the worn out parts of machinaries with alloys.

J. Balachandra, Bangalore.

INTRODUCTION

Alloy deposition is taken to be the process in which two or more metals are deposited simultaneously so that some special properties of the alloy plate may be obtained. The alloy deposits can be broadly classified under five groups. Viz., (1) Decorative (2) Protective (3) Engineering (4) Production of cheaper alloy plate (5) Purely of scientific interest. Certain observations regarding the special properties of the alloy plate have been made. The alloy plates have been found to be denser and harder than any one of the single metal involved. In addition the deposits are more corrosion resistant, in certain ranges of composition, brighter and easily buffed. The deposits have a finer grain structure and are amenable to heat treatment.

COMMERCIAL ALLOY DEPOSITION

Thus with the advantages above mentioned several alloy plates are being used for diverse purposes. Unfortunately, only a few have been comercialised. This is attributed to the fact that in most of the processes studied the Cathode process has been studied in greater detail compared to the Anode process. In continuous use of the bath for commerical plating the Anode process is equally important because the success of the process depends on the type of anode used and the best way of maintaining the concentration of the ions in solution.

For a commercial alloy plate either colour or composition reproduction or both is necessary and in addition the desirable physical properties are hardness, ductility etc. These are dependant on the several factors like the type of bath, the temperature of operation, c.d, pH, "Primary ion ratio", complex ion formation, impurities, to mention a few. In commercial operation, reasonably long stability of the bath, easy maintenance of the "Primary ion ratio", absence of secondary anode reactions and ease of control are necessary.

Alloys of Cu-Zn; Ni-Co; Cd-Zn; Cd-Ag; Cu-Sn; and Ag-Pb have been studied in great detail from the above view-point.

UTILITY OF DEPOSITS

Bright plating baths of Ni, Sn, Zn, Co and brass are deposited for decorative finishing. These are essentially alloy deposits, as the brightness of deposits is attributed to the co-deposition of another metal even if it be in traces. Presence of Se or Zn in bright nickel plate, is instance to the point.

The alloy deposition for protective finishing of metals is closely associated with the above. Cd-Zn alloy Ni-Co, Sn-Zn come under this category. These deposits protect the basis metal better than any single metal deposit. Sometimes separate layers of the metals are deposited and converted into an alloy plate by heat-treating.

Engineering application of the alloy deposits are the use of brass plating to ensure adhesion of rubber to steel, the deposition of nickle-iron on steel strip before heat-tréatment and subsequent electro-tinning the electro deposition of bearing alloys. Several types of bearing alloys have been deposited and tests have proved their performance to be satisfactory. Cugraphite, Cd-Ag for heavy duty bearings are instances. Ag-Pb which cannot be produced by ordinary casting methods can be obtained by deposition. Alloys of 50% Pb and 50% Sn have been used for bearings. All these deposits from practically cold solutions have special advantages over cast alloys.

Carat plating is an instance of production of cheaper alloy plate. In addition to the above extensive studies such as of Cu, Cr, Ni, alloy plates have been made purely from theoretical view point.

PRINCIPALS

In alloy plating the same principles relating to single metal deposition apply. The variables controlling these baths are identical. The e.m.f series is of very little use in predicting alloy deposition results as these deposits are obtained under dynamic conditions. The several variables have to be so combined that the metals depositing have the same deposition potential.

The deposition potential E^d is given by the equation

$$E^d = E^o - \frac{RT}{VF}\ 1_n\ a^{v+} + p$$

P is called the rate factor i.e., the extra potential required to keep the deposition going at a definite rate. To calculate the deposition potl. the value of a^{v+} and p must be known and these depend on various factors like c.d, concentration temp, pH etc., It is they that decide the rate at which the ions are brought to the cathode surface and the rate of deposition. If in a solution the values of a^{v+} and p of the two metals to be co-deposited are near each other, there is likely-hood of co-deposition.

With an idea of the single electrode potentials and the deposition potentials at various c. d's, temp. & pH etc., we can get an idea of the possible voltage and c.d for deposition of the alloy.

Sometimes single deposition studies lead us nowhere, for there are cases of alloy deposition where single metal deposition has failed. Cu-Fe, and W alloys from alkaline solutions are examples.

ANODES IN ALLOY DEPOSITIONS

Anodes used may be one of the three types Viz., (1) Soluable alloy (2) Soluble separate anodes (3) Insoluble anodes or a combination of 1, 2 & 3.

Soluble alloys are the simplest. For example brass, Ag-Cd alloy have been used. A single-phase solid solution type of alloy is normally expected to give satisfactory service. If separate anodes are used careful control of the c.d, on each of the anodes, the potl. drop between them, the p.d, between the anodes and cathode are necessary. Separate anodes of Sn & Cu have been used in speculum plating. The third type has not been employed much. Instead one soluble anode with addition of salt of the other metal have been used with success.

TYPES OF BATH

The alloy plating baths consist of at least one of the normal single metal plating baths, the other being a different bath preferably of a different anion component. This is to avoid the common ion effect. Common examples are Cu-Sn from cyanide stannate bath, Ag-Pb from Ag cyanide and Pb as alkali tartrate comples. The constituents of the bath can be listed as below:

(1) Salts supplying the primary ions.
(2) Salts influencing ionization.
(3) Addition agents controlling the type of plate
(4) Conductivity salts & buffer compounds
(5) Salts improving anode solubility.

INFLUENCE OF VARIABLES IN ALLOY PLATING

The relative mobility of the plating ions depends on the type of bath. The effect of c.d. is that with increase of c.d. the less noble metal in the alloy plate increases. Sometimes the change in plate composition is not much compared to the change in c.d. The effect of agitation is to increase the amount of more noble metal in the alloy plate thus offsetting the effect of c.d. Increase of temperature assists the effect of agitation. Effect of pH is being studied closely of late, and the necessity of keeping pH within limits is impressed. The current efficiency increases normally in most of the alloy plating processes. The throwing power which is dependant on c.d. is critical if the c.d. is critical, for a definite alloy composition. The bath composition influences the alloy plate in that the concentration of the ions in the bath must be maintained fairly constant.

CONCLUSION

The field of application of alloy plates has not been fully investigated. Still there is ample scope for studies in engineering applications, production of new alloy plates for stainless finishing of metals, portection against corrosion and preparation of alloy powders in powder metallurgy.

"THE ELECTRO-DEPOSITION ON NON-CONDUCTING SURFACES"

D. R. DHINGRA, Kanpur.

The electroplating on non-conducting surfaces is not possible, unless they are rendered conductive by some means. There are three methods which are widely used to obtain a metallic coating on non-conducting surfaces, namely: (1) Metal spraying (2) Vacuum spluttering and Evaporation, and (3) Electroplating. The first two processes require the use of special apparatus. The third one has been dealt in detail in this paper.

In order to electroplate a metal on a non-conducting surface, it is necessary to form a thin conducting layer before placing it in the plating solution. This can be done either (1) by means of metal—powders or (2) by reduction of metals on the surface. Both these methods have been described. For copper plating acidic copper sulphate, alkaline copper tartarate and cyanide baths have been tried, but only the least acid copper sulphate and acid copper-sulphate baths have been found satisfactory.

The authors have successfully electroplated several non-conducting surfaces, viz. glass, plastics, wood, wax, plaster of paris and unglazed articles, porcelain and tiles, etc. Paper, rubber and leather articles were not tried but they can be electroplated similar to wood, plaster of paris and wax articles.

For copper plating glass, it is first of all silvered by reducing ammoniacal silver-nitrate either by dextrosol or hydrolysed cane-sugar. Then it is copper plated first of all in the least acid copper bath and the copper film thus produced is then thickened in the acid copper bath. The composition and optimum operating conditions have been studied in detail.

For electroplating plastics in general and celluloid sheets in particular, first of all the surface is deglazed with 90-95% methyl-alcohol, cleaned and sensitised with 1% pyrogallol solution and then a thin silver film is deposited on it chemically, After drying, the silvered celluloid sheets are copper plated, as in the case of glass in the least acid copper bath and finally thickened in the acid copper bath. The copper plated sheets may also be plated with silver in the following silver-plating bath. The composition of the bath is as follows:—$AGNO_3$—74 gms. KCN (95-96%)—82 gm, K_2CO_3-76 gms, $Na_2S_2O_3$ $5H_2A$- 1 mg, water to make upto two litres. The optimum operating conditions are as follows:—Temperature 25-28°C Voltage 3.0 volts, cathode current-density 4045 amO.|Sq-ft. plating time 60 secnds.

For electroplating of wood and wax, a conducting surface was obtained by applying a thin uniform layer of 6% cellodion and after drying treating them similar to celluloid sheets. Wax can also be made conductive by applying a layer of 1:1 copper powder and graphite and then silvering it as usual.

For electroplating, plaster of paris moulds and unglazed articles, they were first of all coated with wax and then treated as in the case of wax articles. Procelain articles and tiles were rendered conductive by direct as in the case of glass plates.

THE STRUCTURE OF THE ELECTROLYTIC ALLOYS

K. C. Mazumder, Tatanagar.

The X-rays studies reveal that the structures of the electrolytic alloys are exactly the same as those of the corresponding alloys made thermally. The study of the Cu-Zn series of alloys which have been most extensively made by both the methods will bring out clearly the regularities of the structures of a large number of binary alloy systems. The phase-diagram of this system shows that there are five well defined phases known as α, β, y, Σ and n the two end phases α and n having the structures of the parent metals. Besides the relative sizes, the valencies of the solvent and the solute atoms also are important in determining the extent of the solid solubility. The boundaries of the different phases correspond approximately to the formula Cu_3Zn_2 for α, $CuZn$ for β, Cu_5Zn_8 for y and $CuZn_3$ for Σ and the ratios of the sum of the valence electrons to the number of atoms are found to be 1.4, 3|2, 21|13, 7|4. The ratios can be more uniformly expressed as 21|15, 21|14, 21|13, 21|12. These also suggest the possibility of the existence of sub phases inside the α -phase. A large number of phases belonging to different alloy systems satisfies the above ratios and when the phase diagrams are constructed by plotting the electron concentrations against temperature the phase boundaries are approximately superposed. The fundamental nature of these ratios has been confirmed theoretically, e.g., the face centred cubic structure becomes unstable if the electron concentration is greater than 1.4. The irregularities shown by some of the phases of different systems have not all been accounted for by the theory. The structures depend in a complicated way on the relative sizes and the valences of the solvent and the solute atoms, their electro-chemical factors and also on the polarizability of the atoms. Some of these irregularities including that of Fe-Al system, and their possible explanations are discussed.

PROCESS OF ALLOY ELECTRO-DEPOSITION AND ITS INDUSTRIAL APPLICATION

G. C. Mitter, Bombay.

The electro-deposition of a metal from solution of its salts depends largely (1) on its electrode potential and (2) its position in the electro-motive series. In fixing the position of a metal in the electro-motive series, however, certain standard conditions are assumed viz.—

(*a*) That the metal is in equilibrium with a solution which is normal in respect to its own irons.

(*b*) That the conditions are such that no disturbing effects such as polarisation, over voltage etc., are present.

One of the conditions for co-deposition of metals will necessarily be to have the electrode potentials to be close to one another in respect of a common electrolytic bath. Copper and zinc have remote chances of co-deposition from an acid sulphate bath for their difference in electrode potential is 1.11. But as soon as this difference is reduced to 0.43 volts employing cyanide bath, the deposition of brass is made possible.

What is significant, however, is that we have to take into account not only the static, but also the dynamic system that actually exists under actual electro-depositing conditions. For example: With a C.D. of I amp|sq. ft. the difference in electrode potential is somewhat less than .43 volts, (.35 volts to be exact) but if the C.D. is raised to 3 amp|sq. ft. this difference becomes almost negligible (.13 volts). Thus conditions could be brought about by effecting suitable static and dynamic changes in the system favourable for co-deposition.

Another factor involved in the process of co-deposition is that of lattice parameter or dimension of unit cell. Following the anology of chemical compounds in which isomorphism is usually encountered in case of substances which belong to the same crystallographic system, co-deposition of metals should be expected from the identity of crystalline form. But if the lattice parameters of the metals to be co-deposited are very different as in the case of copper and lead (copper 3.30 Angstrom units, lead 4.949 Angstrom units) regular entry of lead atoms into the copper crystals lattice would be extremely difficult. In fact it has been established experimentally that in this case alternate layer deposition of copper and lead occurs with noticeable banding *i.e.* no alloy formation takes place.

Once we know these conditions of co-deposition of metals the question of regulating the deposition of relative percentages of metals for alloy formation become important. Certain general principles have now come to be recognised for this purpose. An increase in current density, rise in temperature or agitation all tend to increase the proportion of the more noble metal in the deposit. Increasing the concentration of one metal in the bath usually increases the proportion of the metal, in the deposit, but not proportionately. Instead of alloy anodes, anodes of the individual metals may be used with advantage for it provides excellent means of controlling anode solution for each metal by separate voltage-current density control for the individual anode circuits.

Though the method of formation of electro-deposited alloy from solution is very different from the normal metallurgical melting and casting process, X-ray examination has proved that in every case the structure of the electro-deposited alloy is the same as that of the thermally prepared alloy of the same composition.

Coming to the question of applicability of electro-deposited alloys for industrial purpose, the particular advantages for the preparation of alloys by this method have been very well summarised by Hepburn in the Metal Industry Journal, 1944.

(1) The most common use of electro-deposition of alloys involves the control of brass deposition mainly for the control of colour, the deposit being used essentially for decorative purpose.

But more important is its use in the United States for rubber adhesion. It is found that commercial rubber will adhere to brass (70Cu:30Zn) but to no other metals.

Steel components are therefore 'flash' plated with brass of this composition, the minimum thickness of which is of the order of .00002 in.

Carat gold plating is also an established practice. Binary, ternary and even quaternary alloys have been deposited from cyanide bath in this process. White gold (gold-nickel or gold-tin), green gold (gold-silver, gold-cadmium) and gold (gold-copper) being some of the products.

(2) Electro-deposition of alloys was also attempted to give tarnish-resistance and resistance to corrosion. Silver alloys were specially selected for this purpose. But the requirements of such an electro-deposited alloys are somewhat stringent, for (*a*) it must be tarnish resistant, (*b*) it must have the same pleasing colour of sterling silver, and (*c*) it should also be wear resistant. Silver-cadmium, silver-chromium, silver-nickel and silver-indium has been closely studied, but none of these alloys so deposited has been able to satisfy the specification.

Cadmium-zinc alloy deposition in place of cadmium which is in short supply was tried, but appeared to be inferior in protective properties.

(3) Bright nickel deposit of which we heard so much a few years ago, essentially involves alloy deposition of nickel and cobalt. The Weisberg and Stoddart process, and also the Hinrichsen process are usually employed for this purpose.

Lead-thallium alloys deposited from a perchloric acid bath are among the most resistant to corrosion, and may become useful as protective coatings for steel.

(4) Electro-forming has assumed importance of great magnitude in cases such as building up small or worn parts, for rectifying the dimension of working surfaces of machines or for providing them with a better wearing surface. Nickel-iron alloys are extensively used for this purpose, and especially for cable loading, for when deposited on a copper core the alloys give in addition high magnetic permeability and good corrosion resistance. The co-deposition of chromium and iron (Cr.30 to 45%) has been also studied.

The deposition of platinum-irdium and platinum-rhodium on nickel- wire for sparking plugs was also investigated. The deposition of tungsten-nickel and tungsten-iron for sparking plugs electrodes is interesting in that the presence of a second metal is necessary for deposition of tungsten. It thus indicates the possibility of deposition of rare metals in alloy form which cannot be deposited alone.

(5) One of the most promising development in alloy deposition is the production of bearing metal. Some of the electro-deposited silver alloys are known to be capable of heavier duties than the customary Babbit metal. But the production of these alloys by the casting process is complicated by certain difficulties, chief among

which are, the solid insolubility of lead in silver and the wide difference in melting points. This leads to segregation of lead at the grain boundaries and hence poor bond to the backing metal.

(6) And lastly, production of alloys, which could not be produced in any other way *e.g.* spongy alloy deposits suitable for use in power metallurgy, are only possible by electro-deposition.

"RECENT RESEARCHES ON ANTIMALARIALS"

"REVIEW OF PROGRESS"

LT. COL. JASWANT SINGH, opened the discussion.

There is a growing volume of expert opinion that quinine, as a suppressive antimalarial, can no longer compete with the more potent and less toxic synthetic antimalarials. Mepacrine has proved a useful drug for the treatment of malaria in spite of its several limitations, but is now being given up as more potent and less toxic remedies like Paludrine and Chloroquin, are favoured. The problem of finding a true prophylactic remains unsolved. Drugs from 8-amminoquinoline series viz., Pentaquine and iso-pentaquine (resmbling pamaquin) are being clinically studied.

It may be stressed that for true evaluation of new compounds as antimalarials, each individual member of a particular chemical series should be pharmacologically studied. In this respect, recent advances in the field of *in vitro* cultures of malaria parasites and testing of drugs *in vitro* should receive attention, because such studies will not only yield better insight into the physiology and nutritional requirements of the parasites but will also help us to discover drugs aimed specifically against a particular phase of the plasmodia.

Synthesis and testing of drugs, structurally allied to essential metabolites of malaria parasites, is another notable advance in the field of discovery of more potent antimalarials and provides a sound basis for further research work in this direction. Last but not the least important studies are concerning the degradation of drugs *in vivo* and mechanism of their action. This field of work is relatively incomplete and should receive the coordinated attention of the Chemist, biologist and clinician.

In short, inspite of the notable advances, an ideal remedy for malaria is yet to be discovered. For successful solution of the problem of chemotherapy of malaria, which is considerably complicated by a multitude of varied factors, it is essential that an active and collaborative programme of research should be undertaken in this country as malaria is still our biggest Public Health problem.

STRUCTURE OF COMPOUNDS IN RELATION TO THEIR ANTIMALARIAL ACTICITY

U. P. BASU, Calcutta.

A critical survey on the antimalarial drugs recently studied would show that the antimalarial activity practically lies within a few series of compounds like 5-amino acridines, 4-amino quinolines, 8-amino quinolines, 4-quinoline methanols, biguanides sulfa compounds and O-amino cresols. Search for new antimalarial drugs will still proceed on empirical basis as little is known of the metabolic peculiarities of the malarial parasites.

Attention is being drawn towards the synthesis of compounds that are being found to be the metabolic degradation products of the known antimalarials in the blood and urine of malarial patients. Again from the study of nutrition of malarial parasites compounds that are inhibitors to the nutritional factors are being synthesised in the expectation that they may suppress the development of infection.

The question remains whether an increase in the basicity or mobility in the molecule would impart a characteristic to the compound that might help in forming a drug-enzyme complex, or deprive the parasites in getting the necessary nutritional factor so essential for its metabolism.

A NOTE ON ANTIMALARIALS

S. Mahdihassan, Bombay.

In the treatment of Malaria attempts are being made to replace Quinine by synthetic drugs like, plasmaquine, atebrine, chloroquine, pentaquine and paludrine. But these have a toxic effect of their own even more than that of quinine, as pointed out by Packer (*Am. Pract. June* 1947) Burn (*Background* of *Therapeutics,* 1948) and many others. Further, to enhance their activity Qunine has to be supplemented, as Ganpathi confirms, that Quinine cannot be replaced by Paludrine or Chloroquin (*Ind. J. Phar.* 1947). Qunine is still the best all round antimalaraial known. Research carried out in Cipla Laboratories, Bombay indicates that a special combination of Quinine and Arsenic increases the blood level in Quinine, more than when quinine is given alone. Arsenic in itself possesses an antimalarial power and independently it also increases the activity of the reticuloendothelial system. Hence clinically the above quinine arsenic compound has been found to cure malaria rapidly and to prevent relapse, an advantage not possessed by the synthetic drugs.

D. K. Vishanathan.

Though I am neither a chemist nor a clinician, I shall place a few observations objectively regarding antimalarials. Firstly, no one can codify the requirements of an ideal antimalarial all over the world. Each country has its own objectives dependent upon the degree of malaria prevalence and consequent communal immunity. In this country, for instance, the so-called true causal prohylaxis is impracticable, since a drug with such action is to be taken throughout the malaria season, and for some time thereafter, or practically all the year round. Such a drug will act on the pre-erythrocytes.

Nor again could we attempt at radical cures, because of the hazard of re-infection. It makes no difference to the patient whether his peripheral blood is invaded by pre-erythrocyte forms or exo-erythrocyte forms, in other words, whether he has got a primary attack or a relapse.

For our purpose, a drug of proved utility for the relief of symptoms and, if possible, with a tonic action, will be most suitable. Despite several disadvantages, quinine still holds the field in this respect. It is especially useful in emergencies.

Paludrine has been proved to be extremely cheap and nontoxic for treatment of semi-immune populations with a single dose. For this purpose, especially in rural areas where there is no medical service, paludrine is a very valuable drug. For treatment by medical men or in hospitals, the choice should still be left wide open.

One essential drawback about paludrine is the stimulation of gametocytes, which is of vital importance in countries where there are no national malaria control programmes in a big way, as we have, for instance, in this province, protecting about 12 million people in 3 million homes at a cost of Rs. 40 lacs per years.

Chaudhury has shown that some strains are refractory to paludrine, and this trait is more a parasitic behaviour than host behaviour, since it is maintained on sub-inoculation of the parasite to a fresh host. More recently, Coatney and others have shown the development of resistance after treatment with paludrine in the case of *Plasmodium vivax*—chesson strain.

Chloro-quin is not only not available in this country, but not enough work has been done in this country. So, the scope for further researches is still vast, and until definite conclusions are reached, it would be unwise to interefere with the cinchona plantations prevalent in the country, especially taking into account the fact that a plant takes seven years to mature, and any policy that may be laid down should take into account a sufficiently long number of years. This is especially more vital in view of exchange difficulties and international hazards.

A sumarry of the concluding remarks by Lt. Col. Jaswant Sinfih, Director, Malaria Institute of Inria at the symposium on "Antimalarials" held by the Chemistry Section of the 37th *Session of the Indian Science Congress at Poona on* 5th *January,* 1950.

It might appear from some of the comments that there might be some danger of cinchona compounds coming into disuse, but actually, it is not so.

Considering the large stock of atebrin now available in the country and the indigenous production of quinine it is our policy to take their fullest advantage, along with the use of the synthetic antimalarials, some of which are more potent, less toxic and less costly.

As regards chemotherapy of malaria with quinine arsenic combinations, it may be said that they have been used for years without establishing a foothold. The dosages act not only as antimalarial but tonics also. At present the use of such drugs is a matter of individual choice.

Dr. Vishwanathan referred to the increased production of gametocytes following therapy with palurine. In this connection, it may be said that there is an increase in the numbers of gametocytes produced after ingestion in mosquitoes, but these are not viable for considerable periods. This is an aspect on which further researches are necessary. In the case of therapy with paludrine, certain drug resistant and refractory strains of malaria parasites have been demonstrated but similar instances can also be cited in the case of quinine as well as atebrin.

MOLECULAR STRUCTURE OF HIGH POLYMERS

SANTI R. PALIT, Calcutta.

A complete elucidation of the molecular structure of high polymers is still a very baffling problem. In the simplest high molecular substances various possibilities of isomerism exists which increases to almost astronomical dimension as the complexity of the basic units increase. In the simplest polymer like polymethylene (polyethylene) a number of possible planar arrangements exists, and in vinyl compounds with a number of assymetric carbon atoms the possibility of existence of various stereochemical structures crops up. Diene polymers, again may exist in cis and trans modifications. In addition to these the actual arrangement of the component groups may vary; thus in vinyl compounds the arrangements may be head-to-head or head-to-tail, in dienes the addition may be a 1:2 or 1:4 one.

To gain an insight into the structure of high polymers the orthodox methods of organic chemistry based on chemical analysis have been very fruitfully supplemented by physical methods the most successful of which are (i) X-ray diffraction, (ii) Infared Spectroscopy, and (iii) Chemical Analysis.

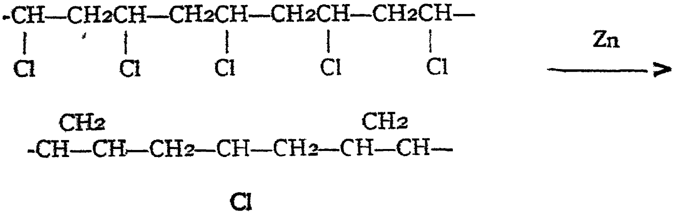
X-ray Diffraction—X-ray examination is possible only for those polymers which are either crystalline or may be oriented by the application of stress. So this method is generally applicable to the case of chain polymers. From the value of identity period and a consideration of the size and geometry of the possible grouping, the structure of the chain can often be arrived at. Thus, by assuming the usual carbon-to-carbon bonding distance and angle, the calculated identity period for polyethylene, the simplest linear polymer is 2.50A° and the actual value is 2.53A° and hence a fully extended zigzag configuration is attributed to polyethylence.

Calculation shows that two hydroxyl groups can just replace two hydrogen atoms of methylene groups in the polyethylene chain if one intervening methylene group is left unsubstituted. This supports the 1 :3 diol structure for polyvinyl alcohol, also since its identity period is found to be 2.52A° all the hydroxyl groups in polyvinyl alcohol must be on the same side of the chain, since otherwise a double or larger identity period would be expected. In polyvinyl chloride the chlorine atom is bulkier and cannot be arranged like the OH groups in the polyvinyl alcohol; the simplest arrangement of chlorine atom is on either side the chain and this is confirmed by the double identity period of 5.OA°. Similar arguments based on X-ray data have led to very interesting conclusion about the structures of many linear polymers including rubbers, Synthetic rubbers and synthetic fibres. However, a complete X-ray analysis and interpretation is very often extremely difficult and hence very few system have been worked out in detail.

Infared Spectroscopy—Infared spectroscopy has been a very useful tool in polymer chemistry. Each individual groups or linkages have characteristic vibration frequencies in the infra-red which is often materially affected by other groups and therefore can be identified in large molecules. The spectrum of polyethylene unexpectedly shows a strong bond due to methyl groups, its intensity corresponds roughly to the presence of one methyl group for every 25 carbon atoms in the chain. It shows also a very weak band of a carbonyl group. This is very interesting since it is known that a small amount of oxygen was essential for the polymerization of ethylene and the presence of oxygen suggests that most probably it acts initiator and is present in the end-group. Hence, it is concluded that polyethylence does not consist of a perfectly straight chain of-CH_2-groups, but is branched at intervals by methyl groups and also there are occassional CO groups instead of CH_2.

Many other applications of this method have been made. For example, this has been useful in the investigation of the butadiene polymer made in presence of metallic sodium. Infra-red spectrum shows three bonds at 909, 990 and 960 em^{-1} frequencies. The first two are shown by diene formed by 1 :2-addition and the last one by 1 :4-addition The bonds in polybutadiene are all of equal intensity and it may, therefore, be concluded that the polymer is formed by 1 :2 and 1.4 addition in equal amounts.

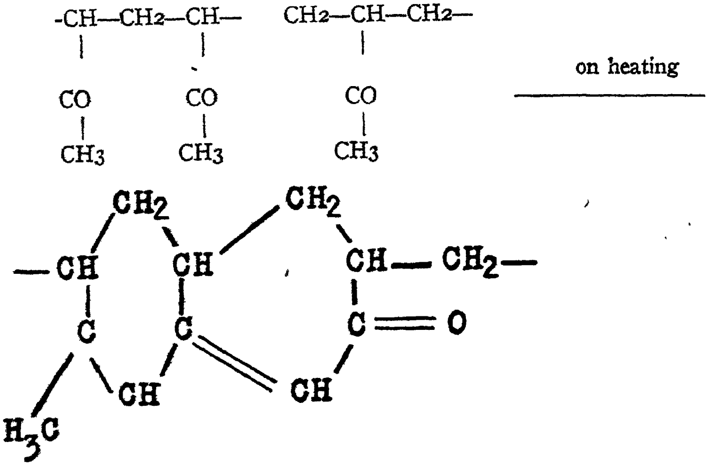
Chemical Analysis—Purely chemical analysis has proved itself to be surprisingly powerful in elucidating the structure of many polymers. An example is polyvinyl chloride. When it is heated with zinc, chlorine atoms are removed in pairs and a hydrocarbon is produced. For a head-to-tail arrangement some chlorine atoms will be isolated by the removal of pair of chlorine atoms from either side and therefore some chlorine, to the extent of 13.5% of the original, will be left; whilst for a head-to-head structure all the chlorine should be removed. Experimental figure for residual chlorine lie between 13 and 16% which strongly support a wholly head-to-tail arrangement.



$$\begin{array}{l} \text{-CH—CH}_2\text{CH—CH}_2\text{CH—CH}_2\text{CH—CH}_2\text{CH—} \\ \;\;|\qquad\quad\;\;|\qquad\quad\;\;|\qquad\quad\;\;|\qquad\quad\;\;| \\ \text{Cl}\qquad\;\;\text{Cl}\qquad\;\;\text{Cl}\qquad\;\;\text{Cl}\qquad\;\;\text{Cl} \end{array} \xrightarrow{Zn}$$

$$\begin{array}{c} \text{CH}_2 \qquad\qquad\qquad\qquad\qquad \text{CH}_2 \\ \text{-CH—CH—CH}_2\text{—CH—CH}_2\text{—CH—CH—} \\ \text{Cl} \end{array}$$

Polyvinyl ketone has been shown to have properties in agreement with those expected for a 1:5-diketone which would result from a head-to-tail arrangement of monomer units. The following change is found to take place on heating which would not occur in the case of a head-to-head linkage as the later produces a 1:4 diketone.



Considerations like above have not, however, been able to finally settle the question of whether head-to-head or head-to-tail, structure occurs in such linear polymers. For example, methyl alpha-haloacrylates seem to be possible exceptions to the head-to-tail rule, as all the halogen is removable by zinc. Here the chemical evidence however is at variance with molecular geometry, since it is impossible to construct scale molecular models for these polymers on a head-to-head plan. Similar difficulties on head-to-tail basis owing to steric factors of the methyl group in constructing geometric models arise in case of the highly crystalline synthetic rubber, polyisobutylene though the chemical and X-ray evidence supports such a structure. This has necessitated postulating structures with the offending methyl groups arranged in a somewhat spiral configuration achieved by rotating the successive isobutene units with respect to each other.

Chelation in aromatic hydroxy compounds has been known to have marked effect on melting point, volatility, solubility, degree of polymerisation, colour reactions and reactivity. Baker showed that it brings about fixation of aromatic double bonds also. It has now been found that it plays an important part in the stability of flavanones and chalkones and their interconversion. A hydroxyl group in the 5-positions of flavanones establishes chelation with the carbonyl group of the ring and this makes the flavanone structure so stable that the corresponding chalkones can be obtained only with difficulty. In the rottleriniso-rottlerin change also this factor of stability comes in Instead of the 7-hydroxy flavanone structure that could normally be expected, the isomeric change proceeds further yeelding a 5-hydroxy compound. Related compounds behave similarly.

TEACHING AND EXAMINATION IN BOTANY

Section of Botany.

S. P. AGHARKAR.

In introducing the subject, Prof. Agharkar gave an account of the types of courses obtaining in Indian University for the Intermidate Science, Graduate, and Postgraduate stages. He stated that, judging from the result of 4 years teaching for the B.Sc. degree, the students had not acquired sufficient knowledge of the plants in their neighbourhood, nor were they able to find their way in their subject. The students had no doubt obtained a certain amount of knowledge of the various branches of Botany and also a considerable amount of knowledge, mainly theoritical, of certain general questions such as evolution, natural selection, variation etc. They were deficient in powers of observation and also in practical work, specially in branches like Plant Physiology and field work. Then defects were partly due to defective curricula, partly to the methods of teaching the subject and partly to unsuitable text book and defective methods of examination etc.

It would be the purpose of the symposium to discuss these aspects the subject and suggest remedies.

DR. A. C. JOSHI.

To enrich the subject of Botany in the country, it is essential that its teaching should be correlated with agriculture, foresty, etc. This can be brought about by more contact between teachers of pure botany and agricultural research institutes and changes in syllabuses. For futher details in this connection reference may be made to the Journal of Indian Botanical Society, 1949, no 1.

DR. B. M. JOHRI.

During the talk the following aspects were emphasised:

(1) Redrafting of the curriculum and syllabus of the elementary course of Botany at the Higher Secondary and Intermediate standard. Much more emphasis should be laid on the study of the plant as a living organism rather than over-burdening the young student with techincal terms without stimulating his thought.

(2) A little more attention should be paid to the sketching work in the laboratory rather than going into too much detail of cellular figures. Proper understanding of the microscopic preparation made by the students or supplied to him is very essential.

(3) Field study should form an important part of all Botanical teaching—elementary or advanced.

(4) Usually the home-examinations have much more lenient rules of promotion than the rules of the official examination because a lesser percentage of marks at the former prompts the students to pay less attention to work. The house examination should therefore be conducted on the same lines as the official examinations.

(5) It was suggested that some attention may also be paid to the economic aspect and applied bias of the subject for obvious advantage to the students.

(6) It was also suggested the it would be of great advantage to the teachers if some sort of refresher's courses could be started and conducted periodically by some of the Universities.

Concluding remarks: The curriculum should be redrafted to give a balanced education to inspire the student and stimulate his thought. He should be brought in closer contact with the plants in the field. Home examinations should be conducted in the same lines as the official examinations Refresher's courses be started for the benefit of teachers.

H. SANTAPAU, S.J., PhD., D.I.C., A.R.C.S.

(1) The cause of the present unsatisfactory state of affairs is the prevalent feeling that in India we cannot expect as much as in foreign university; this feeling must be got rid off if we are to progress in Botany or in anything else.

(2) Students join Botany classes in Bombay university totally un-prepared; the curricula in schools should be changed so as to provide at least the fundamentals of Biology.

(3) Much time is wasted by reduplication of work in Botany; the syllabus should be so orranged that any subject or stage of a subject should not be repeated in subsequent years.

(4) Too much importance is attached to external morphology; students often complain that they took up Botany not drawing and that too much time is devoted to the drawing of morphological specimens. As a result, students often became discouraged and timid, for they find Botany a very dull subject.

(5) Field work is a capital means of creating interest in students; nor is the expense imposed on them too great. Many cheap excursions can be conducted within a radius of upto 5 miles from the college. In my experience, it is only when students have taken part in about ten excursions that they begin to find field work useful and even enjoyable.

(6) Practical work, in anotomy is poor; the reason often is that the razors used by students are of very poor quality. In some foreign universities no student is allowed in the Botany laboratory unless his razor is in perfect condition.

(7) Questions have been often put to me as to how do I find Indian students; are they as keen and competent as their foreign bretheren? My answer is a most definite YES, they are keen and anxious to learn, but either the arrangement of the syllabus or the method of teaching or both very soon dull their keenness; as a result Botany becomes one of the most difficult subjects and students obtain their degree with very little practical knowledge of Botany.

PROF. R. C. LACY, Science College, Patna.

(1) Method and personal contribution of the teacher is more important than syllabus and students quality.

(2) Emphasis on sketch and illustrations should be placed.

(3) Field study and excursions should be devised and improvised.

(4) Teachers should not be hampered by spurious duties, considerations of criteria for promotions and confidential reports.

(5) Inter and B.Sc. teachers should not be made (goaded) to publish research papers etc.

(6) Botany and Zoology Depts. should be quite indept. depts under different heads to allow free development.

(7) Teachers should be made conscious of their *own* morals while conducting examinations as examiners.

APPLICATION OF GENETICS IN ANIMAL AND PLANT BREEDING

Section of Botany and Zoology

DR. B. P. PAL, opened the Symposium.

Dr. Pal said that while plant breeding as an art has an ancient history, it only became a science only in recent years, after the re-discovery Mendals laws of heredity. The discovery that characters are inherited according to certain laws gave a fillip to breeding. It was however discovered soon that "breeding plants to order" was not quite as simple as originaly supposed. Dr. Pal then referred to the advances made possible in plant breeding by the discovers of the phenomena of pure lines, linkage, artificial induction of X-rays pdyploidy etc.

To day the problem of disease resistance in particular, Dr. Pal referred to the problem of breeding for resistance of wheat rusts in India. All the three rusts (black, brown & yellow) occured in the great wheat-growing tract of Northern India & within each rust there were "Physiologic" races; again the resistance of certain wheat varities breaks down when the temperature is altered. This makes the problem of breeding wheats resistant to all the races of rust occuring in the country, difficult. Dr. Pal illustrated his remarks by reference to wheat north or Simla where wheat strains separatly resistant to all the three rusts had been bred. Work was now in progress to synthesise resistance to all the three rusts simultaneously by means of complet crosses.

FACTORS INVOLVED IN THE PRODUCTION OF FISH POPULATION

Section of Zoology and Entomology

Dr. B. C. Basu, Izatnagar, Presided.

The opening address of DR. H. K. MOOKERJEE was read by DR. *B. K.* DAS.

The problem of fish-culture has recently attracted the attention of the Zoologists all the world over. The place of Zoology in scientific fish-culture is indeed very high as for both the culture and utilisation of the marine and freshwater edible fauna a thorough knowledge of Zoology is essential. Therefore, it is a matter of immense gratification that the subject matter like "Factors involved in the production of fish population" has found place in the symposium of the section of Zoology and Entomology of the Indian Science Congress Association. My impression is that the subject of this symposium is to elucidate opinion from the fellow Zoologists who are authorities in their respective lines of investigation and research.

It is indeed regrettable that despite almost every province of India has a fishery department, the scarcity of fish is still prevailing. This is mainly due to lack of adequate number of properly trained personnel and in certain cases absence of a clear cut policy of the departments. I have for a long time felt that many of the fishery officers do not get a scientific outlook for the development of fisheries, because the basic knowledge of fishery sciences is not known to them. There are, however, in many departments senior officers having good Doctorate degrees who have specialised in Chemistry, Ichthyology, Botany, Helminthology, Carcinology, Protozoology, etc., and who are renowned for their research work, but it is a matter of great regret that there is not a single person in any of the departments having B.Sc. degree with fishery science.

Recently, I went over some old reports concerning with the development of fisheries of the Government of Bengal, and I came across in every case the recommendation made by the investigating officer to make adequate arrangement for the training of *fishery science* under the Zoology department of the University. But uptill now no such arrangement has been made by the Government. Such step—motherly treatment by our Government to the fishery science is practically the same all over India. It is presumed that the authorities are of opinion that running of a fishery department does not require any trained person. Ordinary graduate degree holders in arts, science or agriculture having a little common sense can even draw up and execute any fishery scheme. Trained Zoologists are, therefore, not essential for holding high positions in the fishery departments.

I would, now, like to discuss the following points which are, in my opinion, the main factors involved in the production of *fish population.*

(1) Necessity of trained officers.
(2) Survey of waterways for fish culture.
(3) Conservation of fisheries and the prevention of destruction of eggs, fry and brood fishes.
(4) Culture of coarse and edible fishes other than carps, in all the waterways where carp culture is not possible.

To these points seriatim—(1) At present, in my opinion, person entering the fishery department as *production officers* should be expected to possess thorough knowledge of breeding, rearing, spawn—collection, method of transport of spawn and fry, food and culture of all the edible fishes, etc. They should also acquire some experience in the culture of coarse fishes. Knowledge of elementary Oceanography, Rheology, Limnology and statistics for the collection of data and their manipulation are also essential. But it is a naked truth that 99% of our production officers cannot claim that they have even the preliminary knowledge of all the above mentioned subjects. It is a further truth that they did not get any scope for such training. To fulfil this need every University should at least make arrangement to teach *fishery as special paper in the M.Sc. course.*

At present in my department there is a provision to teach fishery as special paper in the M.Sc. course. I have also submitted a syllabus and scheme to the University for the establishment of diploma courses in fishery for both the Junior and Senior students.

(2) Very little survey of our seas, rivers and other waterways from the standpoint of availability of fish and posibility of fish-culture has been made up to date. Consequently we do not properly know the exact nature of our fishery resources. The potentiality of our fishing grounds are, therefore, unknown to us. The breeding culture of fish should, therefore, be surveyed immediately, and enquiry commission be appointed to investigate the right in the fisheries in the main rivers.

(3) In our country no attention is paid, however, for the fish conservation and the establishment of fish sanctuaries. Hence, by playing the parts of robbers, we are only exploiting the natural sources without thinking that there is a limit to it. In this connection the more lamantable fact is that every year millions of fish fry are destroyed for nothing due to the severance of the link between the river and adjacent waterways after the flood is over. As the adjacent flood planes are shallow, they are dried up in the summer resulting in the death of millions of future spawners. Immediate attention should be paid to stop such massacre and wastage of valuable protein diet by establishing sanctuaries within the flood planes. For the protection of brood fishes immediate imposition of close season through legislature is also urgently needed.

(4) In our country the term fish-culture is generally restricted to the culture of carps especially when the question of culture of fresh water fishes comes in. We,

in the majority of the cases, decline to recognise the coarse fishes as culturable ones. Hyderabad and some other places, however, favour to culture murrels better than carps. Indeed, carp culture is a profitable and lucrative business. If it can be done successfully. On the contrary, it is expensive and requires much attention. Besides, there are many waterways where carp-culture is not possible, but the culture of corse fishes is possible with a little enterprise. My suggestion is, therefore, the culture of coarse fishes like murrels, cat fishes, feather-backs, Anabas, etc., should be tried in *beels,* railway cuttings, canals, lakes etc., to increse fish population.

I have restricted my discussion within the four points just now discussed. I, however, admit that there may be many other points which have equal, even more importance than put from my learned friends who are thinking in this line.

Dr. B. Sundara Ray, Lucknow.

It is not clear from the title whether increased production of fish or an increase in the existing "populations" of wild fish, in rivers and Jheels is intended. The two are very different propositions and I deal with them separately below:—

I—INCREASED FISH PRODUCTION.

The "Grow More Fish Campaign" of the Govt. of India and the allied efforts of the provinces and states, are attempts to increase market fish supply. The major carps including the prime food fish do not breed in tanks. It is a well known fact that fish specially carp which are the chief food fish in Indian inland waters lay millions of eggs, not many of which have a chance to hatch and still fewer among the hatched have a chance to grow to adult size. In American waters a survival of upto 2% has been recorded. Adverse physical, chemical and biological conditions are responsible for this heavy loss in nature. If, however, some eggs or fry just hatched are salvaged and nurtured in special ponds and later planted for growth in large tanks and ponds, a great deal of this loss can be prevented without affecting the river fisheries and large crops of food fish which would not otherwise have been available to the public produced for the market. In U.P. the largest experiment in this direction under Departmental control has been conducted since 1944. 573 village ponds which used to produce little or no fish were requisitioned and stocked with fingerlings in 1944-45. After two years of growth they attained marketable size without manuring or special feeding. Ten representative tanks were first fished by the Department and were found to yield a minimum of 10 mds. and a maximum of 30 mds. or an average of 20 mds. of large prime food fish per tank of roughly half an acre in area. The contractors who took the tanks in auction are bound to furnish accurate statistics of catches duly attested by the tank owner and a local village official to assess the compensation payable at Rs. 2|- a maund to the tank owner. The complete data from all the 573 stocked tanks are not available as 279 tanks have not yet deep fished by the contractors who have taken the tanks in auction. From the 294 stocked tanks that have been completely fished an average of 23.8 or 24 maunds have been netted per tank of roughly half an acre. This more than corroborates the results from the 10 Departmental tanks originally sampled. It is, therefore, clear that in the Southern districts of the U.P. which is the home of the four chief food fish Rohu, Nain or Mrigal, Catla and Kalbose, the yield per village tank without manuring or special artificial feeding is roughly 20 maunds per acre per year (= 20 manuds per half an acre in 2 years). Such exact figures of average production from stocked tanks are not available from other provinces for comparison. From the above it can be safely deduced that fish culture can considerably augment natural resources.

II—INCREASE IN FISH POPULATION.

This is a somewhat different proposition. Fishery like forestry consists chiefly in reaping wild crops from nature. The main sources of fish supply in inland waters are rivers and connected Jheels or lakes. The bulk of the fish marketed by fisherman is from rivers and jheels. It is therefore a matter of considerable importance to ascertain how the natural stocks or 'populations' of food fish in rivers and jheels are responding to commercial exploitation by fishermen. Though it is a fact that Indian fresh water fishermen do not possess effective nets and apparatus for extensive capture, still the destruction caused by their methods can be appreciable if it is remembered (1) that fry and fingerlings of food fish found only in rivers are indiscriminately destroyed in many places (2) that the shrinkage of water in rivers and tanks helps the capture of fish on an extensive scale. For this reason when organizing the fisheries of the U.P. I insisted on a well staffed whole time Research Section, one of the duties of which should be to ascertain the condition of our stock of natural fish in rivers and jheels. The only practicable method of assessing fish population available to the fisheries scientist is statistical. The Ganges and its alluents are the only rivers of the U.P.. An attempt has been made at Allahabad on the Ganges to collect random samples of commercial catches of the 4 food fish mentioned above and analyse the samples according to size and number and species: It is hoped that these statistics when finally studied will show the stock of river fish at Allahabad which may be taken to represent the river fisheries of the U.P. By a comparison of the annual records of the Kinds, sizes and numbers, it is hoped that an idea can be gained of the condition of the river fisheries from year to year and to guage how they are reacting to commercial fishing. Any decrease or depletion detected if traced to intensive fishing can be remedied by affording protection to the river or jheel by close seasons, regulation of mesh of net, reducing catches etc. While conservation will help to maintain the stock at a definite level it will not by itself increase the fish population. An entirely new technique has in recent years been evolved particularly in America where improvements to rivers and lakes have been effected by various devices such as Dams, Baffles, Artificial shelters, Control of Predators, Introduction of fish food or its increase by manures etc. Stream and lake management for improving stock of fish as a science has not made much progress. The well known experiments of Gross and Raymont in Scotland have given a great impetus to the use of manures as a method for increasing fish stocks and several experiments are now in progress. The chief limiting factor in India is the high cost involved.

As regards open sea fisheries, the scope for such improvement of stock is parctically nil so far as is known. Conservation measures for protection of stock, however, are possible even for sea fisheries and the efforts of the Fisheries Biologist and the Administrator will be to enforce measures of conservation where ever depletion sets in.

K. Chidambaram, Madras.

The major problems relating to fisheries in any body of water are:—

(1) what quantity of fish will it produce.

(2) how big a crop can be removed and still allow a sustained yield.

(3) what methods will increase production.

(4) how great a financial expenditure is justified to increase production.

These problems can be tackled only with the knowledge of the first two main stages in Fishery Biology, viz., (1) descriptive stage in which the different species of fish are identified and classified and (2) the period of life history investigations. The main purpose of such surveys is to provide a basis for fishery management chiefly through the development and improvement of stocking policies and state wide regulations.

The proper management of large lake fisheries for sustained yield must include consideration of the following (1) reliable fisheries statistics, (2) investigation of the causes and fluctuations in yield, (3) the different groups of fishes and their movements, (4) experimental studies of fishing gear and the behaviour of fish towards various types (5) evaluation of artificial and natural propagation, (6) control and proper use of exotic species of fish. Regarding the fisheries in the reservoir, the following four types of reservoirs have to be taken into consideration:—(1) Irrigation reservoir or storage reservoir, (2) the control or regulatory reservoir, (3) the stock watering reservoir and (4) the power reservoir. It is felt that the value of such reservoir for fishery wealth has never been considered at the time of the construction. In considering the fishery value of reservoirs and irrigation canals, the loss of fish is due to (*a*) inadequate control of the water as it leaves the reservoir and (*b*) the complete draw of the reservoirs, at the head gates and down streams. The protection can be afforded to all the fish to a great extent by the fish screens in irrigation channels and in future it is desirable to have the expert opinion of the fisheries department before any project comes up. In any policy for stocking, it is necessary to follow certain experimental designs for developing and testing a stocking policy. The four main factors which could be used in evaluating the results of a stocking policy the (1) the survival reflected by total catch or yield and stock left in the water (2) satisfaction of the fishermen determined for a given fish by size, condition and quantity of fish, (3) nutritive capacity of the water reflected by their growth, condition and amount of food in the piece of water and (4) the cost production. It is necessary to point out here the need for proper study in the introduction of exotic fish in stocking programmes as such an introduction can upset and complicate the management and some may prove detrimental to the existing fishery as has happened in the introduction of carp in U.S.A. and also because the biological effects of these exotic forms in over-running the waters to the detriment of other animals, as predators or competitors to the existing forms and indirectly by the introduction of parasites and modification of the life history of the introduced fish or the native.

The "factors involved in the increase production of fish population" in the Inland waters can be broadly grouped under the following heads for tackling the problems in a practical manner:—

(a) FISH HATCHERIES:—

Though fish hatcheries are very important in certain respects, it is a matter of doubtful value how far they will be suitable and economical in respect of all fishes. It is imperative that the design of the hatcheries, rearing ponds, fish race, supply of water and water source, feeding problems, control of disease, rate of growth of young individuals, the maintenance of spawners and stocking programme are but a few of the factors which are to be seriously considered.

(b) FISH FARMS:—

Though the small fish farms are mainly to increase fish production, they contribute a great deal to augment the increase of fish population than the breeding and stocking of fish are taken on a large scale.

(c) FERTILIZING FISHING WATERS:—

The fertility of the water depends largely on the same factors as that of the land, *i.e.*, light and plant nutrients and that an improvement could be obtained by supplementing with artificial fertilizers the amount of nutrients available for plant growth. Contrary to the prevailing opinion the fertilizing of fishing waters is not a strictly new development. Some authorities assert that inland fish pond culture has been carried on in China for upwards of 2000 years; a prewar of Carp rearing ponds in Czechoslovakia showed an annual consumption of 386 tons of fertilizer, 2370 tons of ground limestone and 1313 tons of manure and compost. Swingle and Smith of the Alabama State found that ponds receiving water from well fertilized fields supported a high fish production, while those receiving water from areas of low fertility produced fewer and smaller fish. The obvious relationship between fertility and fish production led these investigators to experiment with the addition of various chemical and organic fertilizers to pond water, a process which has increased yields from 100 lbs. per acre for unfertilized ponds to as high as 600 lbs. per acre for fertilized ones. To day as a result of these findings, there are some 7000 fish farm ponds in U.S.A.

Experiments in fertilizing coastal waters of the sea were started in 1942, in Scotland in Loch Craiglin, with the subsidy made available by Imperial Chemical Industries. The lake is 18 acres in expanse and is connected with the sea by a narrow channel. About 10 times the quantity of nitrates and phosphates were added. Within a few months the food for fish increased and the flat fish introduced into the loch increased in length at more than twice the rate; the flat fish attained the marketable size in two years instead of the six years required in the open sea. The work indicated that successful fertilizing of fishing beds connected with the sea can be achieved. In India though it can be said that fish ponds are being fertilized organically there is no rational method in use widely. But a better organised plan to cover different types of waters has to be adopted to know where to apply, when to apply, how to apply and the types and quantities of fertilizers etc.

(d) POLLUTIONS:—

While considering the fertilizing of the waters for increased fish production, it is necessary to know how far destruction of fish in waters due to pollution can be prevented. The effluents from the industrial concerns pollute to such an extent that certain types of pollution are highly detrimental. In U.K. the water pollution Research Board has been doing work on pollution of different kinds including those relating to fisheries. In most of the cases the industrial wastes and discharges are to be reduced by proper agents before they are discharged into the river or stream and it is enforced by an Act of Parliament. But the discharges into the sea are not strictly enforced if it is done at a considerable distance. Some 'pollutions' are good for fish and most of them bad, *e.g.*, waste from milk brewery etc. have been found to be good and also activated sludge and treated sewage have been found to be good for fish. Very little work has been done in India and in view of the programme for industrialisation being taken up more seriously and in view of the need for the protection of the fishery and thus save the food wealth, it is necessary to implement a scheme of work to tackle these problems and make recommendations for proper treatment.

In England the principle enactment for the prevention of river pollution is the River Pollution prevention Act of 1876 which makes it an offence to put solid matter into a stream so as to cause pollution or interference with the flow to discharge solid or liquid matter into a stream and to discharge into a stream poisonous, nexious or polluting liquid proceeding from a factory or manufacturing process. There is similar legislation in U.S.A. and Canada. Recently (1948) a legislation for the control and abatement of pollution has been enacted in U.S.A. to end this type of encroachment on the fast dwindling supply of water for fish to live in.

While considering the various problems relating to the multiple water use, the rivers and streams have to be specially studied in relation to hydro-electric and irrigation programmes, soil conservation and flood control programmes etc. In larger obstructions, it is the duty of the Fishery Biologists to see how far the migration of fish can be aided beyond the obstructions, for feeding and breeding and at the same time bearing in mind the economy involved in such a project. The solution in such cases is the provision for fishways and fish passes and fish screens. The fish screens and fishweirs are more useful in Indian river and canal systems and they are intended to prevent fish from going into areas where they will be lost on the irrigation channels supplying fields, water diversions to hydro-electric turbines factories and they may be made use of for collecting fry and fingerlings for various fishery purposes.

But in the seas the problems are different and it is presumed that it is not proposed to discuss the details here. It is, however, indicated that very many factors affect fish population in the sea. It is necessary to know what is happening to the fish population and the fishery which involves the study of the assessment of fish populations. The annual production of a fish population is defined on the product of the average population on hand and the instantaneous rate of growth, summed over the whole year. The main points to be understood are (1) the distinction between availability as indicated by catch per unit of effort and population as indicated by fishing mortaility and catch and (2) the decline, as fishing increases, in the value of availability as an indication of changes in abundance and the corresponding increase in the importance of knowing fishing mortalities and populations. In assessing the populations the primary factors which enter into the determination of the rate of yield are recruitment, growth, natural and fishing mortalities and emigration and immigration. And the important basic factors are the size of the spawning stock, relationship of spawning to recruitment, factors limiting early survival, mortality rates in the ocean, interspecific relationships, size of competitive stocks, variation in oceanographic conditions and food. Many of the these basic factors are yet to be studied in Indian waters to recommend proper policies for management of the fisheries.

MR. S. BASU, Calcutta.

For an increased production of fishes a clearer and thorough understanding of the physiology of fishes is needed. It is very difficult to know the factors which are responsible for breeding and mortality of fishes.

Experimental observation is needed to find out the effect of individual isolated physico-chemical factors on fish life for protection of river fisheries, river pollution research is needed and a river pollution board should be set up to find out the standard of effluent to be discharged in river without any detrimental effect on fish life.

Sewage which is thrown off as waste should be utilised for fish production.

In the absence of Dr. N. D. KEHAR, Izatnagar, his note was read by Miss K. Gupta.

Fish is essentially a protein food. About 1|5th of the fish is protein and contains most of the essential amino-acids. It has been estimated that fish-flesh on an average contains twice as much tyrosine, thrice as much tryptophane, 4 times as much threonine and 8 times as much lysine as meat. The constituents of fish flesh are different from those of meat in so far as fish contains more gelation and fewer extractives.

In addition to protein, fish contains other nutrients such as fat, minerals and vitamins. The content of fish may vary from 6 to 20 per cent. In only fish and 0.2 to 6 per cent. In white or lean fish.

Fish is richer in phosphorus but poorer in iron as compared to meat. Fish contains higher percentage of iodine than common foods; fresh water fish, as a class, are less rich in iodine than the salt water fish. This factor is of somewhat importance in prophylaxis against goiter. Small quantities of trace elements like manganese, arsenic, lead, copper and zinc are also present in fish.

The flesh of lean fish contains very small quantities of vitamin A but the body oils are rich sources; the chief store being the liver. Thiamine, riboflavin, nicotinic acid and vitamin D have also been found in fish.

It has been stated that the lean fish are better borne by the stomach than the fat fish which are apparently more easily digested than equal quantity of meat. It is quite likely that fat interferes with natural digestion; for not only does fat seem to arrest the normal secretion of gastric Juice, but the fat seemed also to be particularly apt to become rancid and affect the stomach adversely. Fish has a shorter fibre than meat and being relatively easily digestible is frequently prescribed in the dyspeptic and convalescent diet.

Fish flesh is absorbed as effectively as meat. About 97 per cent. of the protein, 90 per cent. of fat enter the blood stream from the intestine. Salted and dried fish are not absorbed so well.

Cooking improves the flavour and palatability of fish but due to its richness in gelatin yielding substances, fish requires a low cooking temperature. Cooking in a moderate oven is the best method to retain nutrints and flavour. However, compared meat the fish diet shows lack of flavour due to the poverty of fish flesh in extractives. It is recommended by some workers as a substitute in the dictary of epileptics and sedentary persons.

From the economic point of view fish are moderate to expensive for protein, and extravagant for calories. The market price of fish is not at all an index of its nutritive value. Very often the cheap and despised varieties are richer in protein than the usually esteemed delicies. As an energy supplying food, fish should be evaluated on the amount of fat present in it. From this point of view, lean fish has a lower nutritive value than fat fish or meat. However, the nutritive value of fish can be increased as it can take a considerable amount of fat during cooking.

Fish is regarded erroneously by some as a valuable brain food and also to possess aphrodisiac qualities. No scientific evidence is available in support of these popular fancies.

One note-worthy point in the composition of fish as used for human consumption is that it contains a large amount of waste material. In fish as sold, the waste may amount to 70 per cent. and even in fish as served, it may be as high as 35 per cent. The waste itself is fairly rich in the nutrients. At present many indigenous species of fish are being exploited for production of liver oil as sources of vitamins A and D. In foreign countries, where the possibility of using the whale-meat for human consumption by canning with vegetables is being exploited, it is being used in larger amount for animal consumption. Likewise the giant fish that are being landed on the Indian shores essentially for the extraction of liver oil and are not acceptable for human consumption can be used as cattle feed.

The Animal Nutrition Research Laboratory of the Indian Veterinary Research Institute, Izatnagar, have in collaboration with the Fisheries Department undertaken extensive investigations on the use of fish meals as cattle feed. It has been found that though the chemical composition of fish meals prepared in India varies according to the place of collection, the method of manufacture and the species involved; the over all impression gained is that fish meals prepared in this country are very rich sources of protein, calcium and phosphorus. Experiments have shown that after the first few days, when fish meal is incorporated in the ration, the animals get easily accustomed to it. Observations extending over feeding periods of 30 to 45 days have shown no adverse effect on the health of the animals even when their digestible crude protein requirement was supplied solely from fish meals. The animals on fish meal rations maintained excellent health and showed positive retentions of nitrogen, lime and phosphate. The nutritive value of these fish meals with regard to the digestible crude protein content, compares well with good quality tankage or entrails and is much higher than commonly fed concentrates of vegetable origin.

It may be emphasized that the salvation of an undernourished nation, with an acute shortage of protein in food stuffs lies in augmenting the various protein-rich food resources. In our coastal waters extending over 3,000 miles in lakes, rivers tanks and ponds stands an unharvested crop of the most nutritious foods both for human being and for cattle. It is time that concerted efforts are made to exploit this source. Fish, just like other food of animal origin, e.g. milk, eggs and meat has a high protective value. In the Indian Union where *per capita* consumption of milk is so small with so much prejudice against eggs and meat, fish has special role to play in improving the illbalanced cereal diets of the people, as fortunately there is not the same prejudice against fish eating.

DR. H. S. RAO, Madras.

How population of more marine fish could be increased. As all factors could not be discussed therefore no resolution should be sent to Government.

DR. P. SEN, Calcutta.

As the opener of the subject is not present we should not continue the symposium.

DR. B. K. DAS, Hyderabad.

In summing up Dr. Das pressed for intensive teaching of fisheries science in Indian Universities. The problem of fish and fisheries is very vital from nutrition point of view. The emphasis should be on fishes and not fisheries study. We should do our best to improve inland fishes. In Hyderabad a survey of 3,000 tanks is being conducted for this purpose.

For want of time the following note could not be read and was accepted as read.

P. I. CHACKO and S. V. GANAPATI, Madras.

INTRODUCTION.

When compared with the total area of sea water, which occupies nearly three-fourths of the earth's surface, the area of the fresh waters of the globe seems to be insignificant. It may therefore strike one that the potentialities of marine fisheries are far greater than those of inland fisheries. But the view is steadily changing in the light of modern aquicultural experience. Allen (1917) has compared the yield of organic substances from a given area of freshwater, seawater and land thus.

Continental carp pond	95	lbs of fish	per acre per year.
Enclosed harbour	89	,,	,,
Cultivated land	73	beef	
Fish from North Seas	15	fish	,,

Further transport facilities and shortage of refrigeration machinery have stood in the way of sea-fish being carried to the people living far away in the interior from the coast. This situation has been responsible for creating the need for local self-sufficiency in all the matters affecting food, especially freshwater fish. The Royal Commission on Agriculture in India and the recent Famine Commission in Bengal laid stress on the development of inland fisheries as one of the most urgent measures of rural amelioration.

India is a land of villages and also of big rivers, reservoirs and tanks. The latter are capable of producing more fish than they do at present; and there are also large undeveloped pieces of water in the form of village tanks, which have not yet been developed to the extent to which they have been done in the West. Worthington (1939-40) has stated as follows in connection with the development of inland Fisheries in England which merits quoting here. "Most of these waters should be potentially capable of supplying an annual crop of 5 to 100 Ibs per acre per annum. But at present, the largest part of them is hardly cropped at all for purpose of food. Under a careful management the freshwaters could provide a not inconsiderable addition to local food supplies. By contrast, the flourising fish-pond industry of Germany reckons to provide fishes in crops upto and over 500 Ibs per acre per annum. This production is not only of carp and other coarse fish which are not considered at present with much favour in Britain but includes rainbow trout which in Britain are used only in the luxury trade. It is a striking fact that in peace time nearly all the rainbow trout on the British market are imported from the continent at prices with which poachers could hardly compete while in places such as Munich, rainbow trouts are grown in ponds fertilised with sewage effluents at the cropping rate of 500 lbs per acre per annum".

In order therefore to increase production of fish in our country, our fish forming operations should be governed by certain principles and factors which are discussed below.

Making the best use of every piece of water should be the foundation of a sound fish production programme. A better yield can be expected from those ponds which can be drained easily. Lands which are too water-logged or too poor for agricultural purposes may be converted profitably into fish ponds, which after a suitable treatment may be made to produce a good harvest of fish.

Fish culture in farm wells:—Though ponds are fairly used for fish culture, farm and irrigation wells which are innumerable in our agricultural country have not been properly used. The ryot, who seeks to grow more food on his land with water from the well, could at the same time grow fish in his well and reap a double harvest with very little extra labour. Experiments conducted at Madras have proved that quite a number of fishes, such as Etroplus, Gourami, Chanos, Mirror Carp, Labeo, etc., could thrive in wells and that an average fish crop of 10 to 50 pounds could be obtained from each well of about 100 sq. ft.

Paddy-cum-fish culture:—This method of increasing fish production has to be popularised in all deltaic areas. Paddy-cum-fish culture is extensively practised in Japan, China and in East Indies. Even in Bengal, simultaneously with the paddy crop, a fish crop of 100 to 300 lbs per acre is usually harvested in certain areas of the Sundarbans. This method has great possibilities in the East and West Godavari districts in Madras Presidency. Carps like Catla, Labeo, Mrigal, Rohu and Calbasu can grow with paddy.

Utilisation of sewage:—As in Germany and other European countries attempts have to be made to utilise the sewage effluents of all cities and municipalities for fish culture, by which a crop two or three times greater than of ordinary water can be obtained. Active propaganda is required for this new line of fishery development. In Madras, arrangements are being made to utilise the clear effluents of Madura, which are now allowed to run waste, for fish culture.

Utilisation of religious institutional waters:—The large number of ponds and tanks under the control of religious institutions like temples and mosques are at present un-exploited for fish production. Under the Grow More Food campaign, the Madras Fisheries were able to persuade many temple authorities to allow pisciculture in their waters with due regard to the religious functions of the temples. The results are very satisfactory, as the ecological conditions of these waters are quite favourable for fishes like Chanos, Catla, Cirrhina, Barbus and Labeo. The optimum conditions such as temperature, light, nutrient substances and algal growth are found in abundance in them. By proper propaganda all religious institutional waters can be profitably utilised for increasing fish production.

Utilisation of drinking water reservoirs:—At present drinking water reservoirs are not used for fish culture. Fearing that such a procedure would endanger public health. This conception is not correct, as the water from these reservoirs are usually filtered before supply to the town. Culture of fish would only on the other hand enhance the purity of the water as fish feed on algal growth and other decaying matter. The cost of chemicals used in purification can be considerably minimised.

Prevention of mortality:—Large scale mortalitites of valuable fisheries commonly occure in the tropics due to various causes. These incidences have to be promptly prevented by taking suitable steps such as regulation of water level, aeration of water and rescue operations, if such losses are to be prevented.

Prevention of pollution of waters:—The discharges from various factories, mills and industrial plants into rivers, streams and reservoirs cause deleterious effects on fish life. This loss has to be prevented by suitable legislation to enforce the mill and factory owners to dispose their effluents either elsewhere or to treat them as to make them harmless to fish life.

It is essential to remember always for increased fish production that just as in agricultural practice aquatic manuring of fish ponds with appropriate fertilisers is absolutely necessary and that careful attention should be paid to periodical cropping if fish of good size are to be obtained. Apart from the above, certain factors which may be classified as physical, chemical and biological, have also to be taken into account in this connection.

PHYSICAL FACTORS.

Among the important physical factors may be mentioned depth of water, water-level and shoal area, wave action, erosion and silt, and temperature, colour and transparency of water. The significance of each of these factors in increased fish production is discussed below.

Depth, water level and shoal area of water:—The shape, size and depth of a lake determine the relative amounts of shallower water. The great the area of shallow water the greater the biological productivity. Hence depth and not volume of water is the most important factor in determining a lake's fish producing capacity. A lake of 50 acres with an average depth of 80 ft. would produce less fish than a lake of the same area and kind of water but with an, average depth of 10-20 it. Shallow lakes therefore yield more fish per acre than do deep lakes, because they provide a greater abundance of food, of weed beds for shelter and of suitable spawning grounds.

Long narrow lakes with irregular shore line due to islands and bays are generally much more productive than relatively circular lakes, for incressed irregularity of shore line results in (*a*) greater contact of water with land, (*b*) increased areas of protected bays and cover, (*c*) increased areas of shallow water for growth of rooted vegetation, (*d*) reduction of the amount of exposed, waveswept shoal, and (*e*) increased opportunity more extensive close super-imposition of photosynthetic zone upon the decomposition zone. These and other possible results help to increase the production of microbiotal food of fish. Therefore the form of a lake basin determines the productive volume where the several food cycles take place.

Fluctuation in water level in lakes having a gently sloping sides has no effect on shoal area, while it has opposite effect on lakes having steep banks. Increase in shoal area will tend to (*a*) raise the water temperatures, (*b*) benefit the food supply and fish production, (*c*) increase the breeding habitat and production of fishes, (*d*) constitute danger zones to fish like by affording opportunities for the fish eating birds, (*e*) favour disease organisms and excessive growth of weeds, and (*f*) cause algal nuisance.

Decrease in shoal area, on the other hand, will result in lowering of temperature, shelter, vegetation, spawning beds, food, erosion, predators and disease. In general any decrease in the area of shoals will tend to lower productivity which is seldom desirable except in lakes suffering from excessive weed growths and algal nuisances. It is therefore desirable to have a permanent and constant water level for fish productivity. Fluctuating water levels are apt to be injurious the other ways also. A drop of a foot or two during spawning season may destroy the eggs of most fishes: cause considerable loss to fish life, prevent the establishment and normal development of weed beds. For these reasons it is advantageous if a lake surrounded by extensive areas of marsh or low lying ground is provided with arrangements for slightly raising its water level.

Wave action erosion and silting:—Ponds and lakes unprotected on all sides by barriers are those which produce strong wave action. It is unfavourable to fish life in shallow lakes and on the shoal areas of deep lakes. Waves prevent the formation of weed beds, eliminate fish-food by smothering the bottom organisms, destroy the spawning beds, cause bank and bottom erosion, keep the water rolled and increase the turbidity of water. Thereby the depth to which light can penetrate into water is reduced and the production of fish food is decreased. Wave breakers built of stone boulders or logs along wave-washed shore will prevent wave action and help increase fish productivity.

The sedimentary products of erosion tend to fill lake basins and thus shorten their life. Sand and mud tend to smother the food organisms on the shoals, diminish the penetration of light which is indispensable for chlorophyll bearing plants. Sometimes coarse vegetation is destroyed leading to extensive algal nuisances. On other occasion they lessen the production of plantonic organisms which are at the base of the fish food cycle. But it may also be argued that the sand and mud from the catchment area contain fertilising elements which are necessary for increasing the basic fertility of the aquatic soil. It is safer to allow the nutrient substances in a dissolved form as a result of slow leaching action than allow the surface soil of the surrounding regions to be washed into the lake directly. Devices for silt-catching are therefore necessary in such cases.

Temperature:—All life processes are speeded up by a rise in the temperature of water. A rise of 10°C is said to double or treble biological activity. So, lakes and ponds subjected to higher range of temperature give rise to increased production of fish, since the increase of fish food especially is accelerated by higher temperature. Density and viscosity of water decrease with increase of temperature and are responsible for the migration of organisms to deeper waters. Temperature limits most favourable to fish life differ widely according to species. It is very difficult to determine the upper limit to temperature which can be tolerated. The heat may not actually kill fish but may make them susceptible to parasites or diseases. Trouts and English Carps prefer cold waters while Pearlspot and Gourami require warm waters.

Chanos, Mirror Carp, Scale Carp and Leather Carp are however found to grow at a rate of two to three inches per month in the first year when grown in fresh warm waters. Attempts should therefore be made to culture quick growing cold water fishes in warm waters.

Colour, transparency and turbidity:—Clear, blue or green water contain less living and dead matter in suspension while more yellowish or brownish or greenish water contain more of them. They constitute the food of fish. Light penetrates clear water to great depths, and influences the migration and distribution of animals. Silted lakes are highly turbid and are almost entirely devoid of weeds except perhaps in shallow water. Clearer waters allow the light rays to penetrate far enough to permit luxurient growths in rather deep water. Turbidity is also caused by wave action on eroding shores, on soft bottoms of marl, mud or peat, by inflow of silty streams, by heavy algal growths especially after a bloom, by cattle wading and rolling the bottom. Lakes and ponds should therefore be kept free from these disturbing factors.

CHEMICALS FACTORS.

Among the chemical factors, which play an important role in increased production of fish, may be mentioned the differences in the chemical constitution of the which are primarily responsible for the varying fertility of the aquatic soil on which the entire fish food cycle is based.

Phosphates, nitrates and silicates, which are released into the water from bottom sediments, where microbes decompose the highly complex dead organic substances into simplest substances, are utilised by the chlorophyll-hearing plant organisms for their assimilation. These organisms form the food of fish or the food of zooplankton, which in turn forms the food of fish. The presence of the above inorganic nutrient substances is therefore essential for increasing fish food. Whenever they are absent in lakes and ponds, their deficiency must be restored by frequent manuring with appropriate fertilisers, until there is a formation of a bloom in the water.

The nature of the bottom deposits is extremely important in the formation of the nutrient substances of biological significance. If the sediments are composed of a mixture of rotting organic matter derived from dead animals and plants found in the pond and fine black silt containing essentially of black ferrous sulphide, the effect of the fertilisers spread on such a bottom will last for longer period than when the sediments consist merely of sand and mud. Hence, mud bottoms consisting of rotting vegetation and fine silt should be created where there are none in fish ponds, if productivity is to be augmented.

Along with the above substances, addition of calcium salts is also necessary for increasing fish production. It has been found that fish production in "soft" waters is far lower than in "hard" waters. A minimum amount of 65 parts per 100,000 of Calcium as $CaCO3$ is very essential for really good production. If this amount is absent, it is essential to increase the concentration of calcium by the addition of powdered chalk or limestone to fish ponds. Thus, making good the deficiences in the natural supply of salts is the most satisfactory way of increasing fish productivity of a lake or pond. Waters high in carbonates tend to produce more crustaceans and molluscs which form the food of fish. Snails and shrimps may be introduce after noting the ecological requirements of the different species of fish cultured in the particular water.

BIOLOGICAL FACTORS.

Knowledge of the bionomics of fish:—The growth and reproduction of fish depends on the availability of its food in its habitat. Rearing of fishes in ponds and other inland waters to meet the public demand for increased fish-production cannot be successfully accomplished without a knowledge of the food and feeding habits of the fish cultured at different stages of their growth. A knowledge of the bionomics and feeding habits of fishes stocked is thus essential for incresing fish production. Increasing the natural food supply by the application of chemical fertilisers is the easiest way and with proper care an increase of 100 fold is easy to obtain.

Spawning facilities:—A fishery cannot be perpetuated and increased if adequate spawning facilities are not afforded. Breeding grounds in the rivers should be conserved and protected. Where dams and anicuts are constructed artificial runs have to be provided. In ponds and tanks breeding facilities such as introduction of submerged plants and hard substrata should be given with due reference to the spawning habits of the fish under culture.

Augmenting fish seed supply:—Increased production of fish depends a rational policy of stocking of inland waters. The most carefully designed plan of fish stocking is useless without the raw material in the form of young fish which must be derived from the natural nursery areas and artificial breeding ponds. The fact remains that each fishing planted in a pond, lake or river is an increment to the normal fish resources of that body of water. This aspect emphasises the vital role of nurseries and hatcheries. Mention may be made here of the abundant sources of seed of saltwater species such as *Chanos chanos, Etroplus suratensis Mugil spp., Megalops cyprinoides* and *Lates calcarifer* along the estuaries, backwaters, and tidal creeks, which could be easily acclimatised and reared in freshwaters. Mention may also be made here that seed of cold water fishes such as the Mirror Carp, Scale Carp and Golden Carp and Tench which could be easily acclimatised and grown quicker in waters of the plains. Advantage should be taken of the availability of millions of hatchlings in the rivers like the Godavari, Krishna, Tungabhadra, Cauvery and the Thambaraparani, during the flood seasons. Suitable nurseries should be constructed in a number of places along the banks of these rivers. Where the hatchlings can be reared, sorted out in the fingerling stages and then transported into the interior for stocking purpose.

Stocking of ponds with fish of different age groups and species:—Different species of fish have different feeding habits. Some are bottom feeders, others column feeders and still others surface feeders. By introducing these three groups in a pond the entire food available in it can be utilised: and thus maximum production obtained.

Control of vegetation:—Reeds, rushes and sedges should be periodically cleared from a fish pond. A good submerged vegetation in a third of the lake or pond is desirable as it oxygenates the water and provides cover for the invertebrate fauna. The vegetation affords spawning facilities for some fishes. Where the growth of vegetation is poor, the provision of shelters of brush wood or heaps of stones is advantageous for increasing fish production.

DR. B. K. MITTRA, Calcutta.

This problem is most important and opportune as the out-come of discussions will greatly help the cause of Grow More Food' campaign launched by our National Government.

Utility of fishes is manifold, though far being exhausted. Fish is a source of many useful constituents to a country, such as Vitamin-rich Liver Oils, Crude Oils, Gelatine (from scales), Glue, etc., apart from its being a very nutritive food rich in protein of high biological value. Decomposed fish is also a very good manure for stimulating growth of various agricultural produce. It should therefore be considered essential that fish farming, fish catch and fish transportation should be given top priority in an all round development of the country.

It is well known that while most fishes lay thousand or even million of eggs in water very few of them could live after fertilisation on account of various factors and fish population therefore cannot increase as is expected. If these factors which contribute to an increase in mortality could be controlled, fish population in a bed may be enormously raised. The following are some of the methods which are adopted for increassing the fish population.

(1) River beds or other stream beds of varying depths in such parts of the river or stream where water is more or less stagnant, are to be selected and maintained for fish breeding. The water of such parts of the stream should have a suitable pH and should contain suitable concentration of Ions which favour the growth of fish spawn.

(2) The eggs after fertilisation and developments into spawns are to be removed to shallow *Nursing tanks.* wherein favourable conditions (such as suitable pH and salts) for the growth of infusoria and small crustacea a good food for the spawns, should exist. In some cases artificial manures are to used with good result. These spawns should be protected from carnvornous fishes by suitable arrangements as developed recently in U.S.A. and other places.

(3) After spawns developed into Frys and Fingerlings are to be removed to deep tanks freed completely from all sorts of carnvorous fishes which eat them up. Proper attention should be given to water in these tanks, so that it may not in any way be polluted by sewage or any other filthy water. It is essential that proper aquatic plants and weeds grow in the beds of those tanks. Further unless there are rows at tall trees around such tanks, the frys and fingerlings are not stimulated to swim about in the tanks a condition very necessary for their healthy development. Care should always be taken to see that ample supply of food and occasional supply of manures including artificial manures for developing frys are maintained in those tanks. Periodic meeting in the tanks after the fingerlings have attained certain size, is also desirable.

These are some of the essential conditions for increasing the fish population in beds and unless these conditions are satisfied, tall talks about cheapening fish in the market would eventually end in smoke.

It is thus evident that to ensure all these onditions in villages and towns of our unhappy country there should exist a big battalion of well trained experts who could infuse proper and upto date knowledge into the ignorat fishermen of our country who would really bring up the fish into the tanks from streams and rivers. Such an array of experts can be mobilised in a short time only when proper training centres are opend in various parts of our provinces Further there should be an well equipped central college for higher teaching and research in Pisciculture.

TEACHING OF ENTOMOLOGY IN INDIAN UNIVERSITIES

Section of Zoology and Entomology

DR. B. C. BASU, Izatnagar, presided.

DR. H. S. PRUTHI, New Delhi, opened the discussion.

It is well known that by far the great majority of animal species in the world are insects. These tiny and insignificant looking animals play a very important part in the economic welfare of mankind. A large number of them feed on agricultural crops and forest nurseries and trees and thus decrease their yield and damage many valuable plant products in the open or during storage. A number of insect species spread human and livestock diseases. Insect cause considerable damage to military stores also. In Depots of the Eastern Command alone this loss amounted to about ten lakhs of rupees. On the other hand some insects, are responsible for some important industries such as Lac, Silk, Honey etc. and thus increase the economical resources of mankind.

As regards damage to agricultural crops, at a conservative estimate losses due to insects amount to about 10% of the crop yields. In the case of food crops alone, which is the burning question of the day, insects destroy between 4—5 million tons of grains which is considerably more than our annual imports of food grains at present. As regards human diseases, one need refer only to malaria, plague, Dengue fever, Yellow fever, Filariasis, relapsing fever, Cholera, Small pox etc. Which are spread by mosquitoes, flies etc. It is well recognised that the production of Indian industries will increase ten times if measures could be taken to protect labour from the attacks of mosquitoes. The value of country's wealth which is thus being wasted at the hands of insects is therefore incalculable. Similarly the working capacity of Indian cattle is considerably reduced due to Surra, Theileriasis, Babesiasis and other diseases which are caused or spread by insects, ticks,etc.

Researches on insects have been in progress in several Institutes in the country but almost all of them belong to the Department of Agriculture, Medicine etc. Naturally therefore the researches have been of a Applied nature. It is well known that the most reliable basis for such research work is fundamental research in the science concerned. Unfortunately very little fundamental research in the entomology has been carried out in India so far. The right and most appropriate place for such research are the universities and the fact that almost in all the advanced countries in Europe and America the university laboratories are devoting considerable attention to research in Entomology is well known.

Teaching cannot be separated from research. In fact unless a subject is properly taught to students, they are not equipped for doing research work in that subject. In almost all the Indian universities teaching of Zoölogy occupies an important place and the zoological departments are carrying out considerable amount of research work on various groups of animals. In view of the importance of insects as explained above, it is extremely surprising that insects are receiving very little attention both in the teaching of Zoology and research in that subject. Apart from the important influence which insects have on the economic well being of mankind, this group affords an extremely interesting material for the investigation of general zoological problems such as those of heredity, genetics and animal breeding. The classical work on animal breeding on the basis of Drosophila fly in America may be cited in this connection. Insects are valuable material particularly because they are small in size and can be multiplied quickly in the laboratories and therefore in a single year a worker can carry out observations on a number of generations and on thousands of individuals. The results of such work therefore would be very reliable, having been based on such data.

In the sphere of Social Biology, insects also provide excellent material. The mode of life of termites, bees, ants etc. is organised on an extremely interesting and economical basis which can serve as a model for man to copy. Thus Entomology should receive adequate attention in universities and their Zoological departments not only for helping the solution of economic problems but for improving the teaching and research in the subject of Zoology itself.

As regards actual place which Entomology should occupy in a teaching syllabus, it may be pointed out that in many European and American schools, children are given object lessons on insects as part of their course in general science. In High or Secondary schools insects occupy a prominent position in the teaching of Biology. In the universities there are Chairs, Readerships, etc., in all the important universities. In view of this, proper introduction of insect study in the first year of student's entering into a university is not too early.

MR. P. S. NEGI, Ranchi.

In numerical strength the insects outnumber all other groups of land animals put together. They afford numerous characters of purely scientific interest. Some of them have a remarkable system of organisation and habits from which man can derive a very great lesson for the development and betterment of individuals and of human race as a whole. Insects affect man in many more ways than any other groups of animals dose. In spite of all these factors, in India, study of entomology is neglected in the Universities which are the makers of scientists and literature of the country.

India is an Agricultural country and whatever may be its industrial development in future, the importance of its Agriculture cannot be overshadowed by any other development. Agriculture will ever remain the hub of all round development in India.

Looking from the three principal angles of human development and welfare, viz. (*i*) health (human and animal), (*ii*) food and housing and (*iii*) economic uplift; entomology plays a very important role in all these spheres.

Health:—Many of the diseases in man and his cattle are either insect caused or insect borne. Cholera, malaria and plague, which take largest toll of Indian life year after year, may be cited as an example. The Bot flies (Oestrid) cause an extensive damage to our domestic animals, to our dairy products and hide industry.

Food and housing·—It is the first necessity of life.

A normal healthy diet, broadly speaking, consists of cereals, fat, fruits and sugar. Here again, insects play a very important part both in growing of plants and fruits as well as reducing their production. It is well known that a large number of species of insects are responsible for pollination in the plant kingdom to enable them to propagate and to bear healthy fruit. On the other hand equally large number of insects are responsible for direct damage to our food crops, grains, fruits, forests and timber.

To cite a few instances of destruction insects, locust is a familiar insect which causes famine. Weevils are reported to destroy annually over 3 million tons of food grains, white fly pest destroy citrus orchards and reduce the yield of fruits to less than 50%.

In one outbreak in 1926, the *sal* (*shoroea robusta*) borer (*Haplocerambyx*) is recorded to have killed over 60 lakhs (6 million) of *sal* trees in a few forests of Madhya Bharat and Central Provinces; the loss was estimated to 137 lakhs of rupees. *Sal* is one of the important timber and fuel of India. Termites (white ants) are notorious for their extensive damage to furniture, timber and even to other household articles.

Economic development:—There are several insects which are beneficial to the economic development of the country. The outstanding examples being the honey bees, the lac insects and the silk, *tassar* and *eri* moths.

The honey bees provide not only honey which is the best of the high energy producing food in health as well as in sickness but also the bees-wax used in several industries. If the bee industry is developed properly, it has internal high food value to our people and enormous export value to earn foreign currency.

The lac insects, the most prevelant species of which is known *laccifer lacca* provides us with an industry which is virtual monopoly of India. Before the advent of aniline dyes, it was valued all over the world for its beautiful red dye called 'crimson lake'. Now it is valued equally well for its resinous product called lac in crude form and shellac in its refined form. The insect produces the valued and the only natural resin of animal cum plant origin and also wax next best to the carnuba wax. The lac dye is beautiful crimson colour. It is still used to some extent in the country. These days lac trade brings to us annually about 15 crores of rupees from foreign countries. This important national industry of the country suffers an annual loss of over five lakhs maunds amounting to a loss of about three and a half crore rupees at the hands of the enemy insects.

The last though not the least important are the silk. Tassar and eri moths which enable us to manufacture beautiful silk cloth and sarees of Banaras, Mysore, Malda, Bhagalpur and Assam for internal consumption as well as for export.

Entomology having such varied and important position in our country should surely find an impertant place in our Universities. We are the first to classify the insects and call them *sat-pada* (six legged) in first century A.D., hundreds of years before P. A. Latvilla (18) invented the term *Hexa-poda*. Control measures against certain harmful insects and intimate knowledge of some beneficial insects like silk worm, honey bee and lac insect were known to India at least more than 6,000 years ago, but to day, practically we lag behind every modern advanced country in the advancement of the modern science called Entomology. In west, in every well known university teaching of Entomology has an important place in its Zoological department.

If we are to develop and advance our agriculture, forestry and animal husbandry, our cottage and subsidiary industries, Entomology must find a proper place in our universities. They must have at least a Readership in Entomology and recruit trained Entomologist of practical experience for these posts. Entomology not only opens a vast source of employment for our Zoology graduates but study of Entomology also involves ecological and statistical studies of animal cum plant life which is the pivot for the development and advancement of all sciences and human progress.

DR. A. P. KAPUR, Calcutta.

On account of the great number of insects and their bearing upon human welfare, the science of Entomology deserves an important place in the teaching activities of the universities. The Zoological courses that are being followed at present in most Indian Universities are inadequate in so far as the teaching of Entomology is concerned. In the Intermediate years very often Entomology is taught to the cockroach or the mosquito-stage. In the one or two post-intermediate years, only a silght advance is made in this direction. It is in the post-graduate years that the student is required to learn a good part of Entomology, provided he chooses it as his special subject. Those who take up some other subject instead go out with Honours of M.Sc. degree in Zoology with but a fragmentary knowledge of Entomology. inspite of the fact that nearly half the species known of the animal kingdom are insects.

I think that the root cause of the present unsatisfactory state lies in the fact that very little of Entomology is taught in the undergraduate years. Obviously a lot would depend upon the introducing of Biology as a distinct subject in the schools so that in the Intermediate and post-Intermediate years, more of Botany and Zoology could be taught. The central theme of these courses should be the application of Zoology (and Botany) to meet human requirements and the scientific approach to human problems. If this is done properly, Entomology is bound to receive the attention it deserves and occupy a rightful place in the teaching of Zoology in the Indian Universities.

DR. S. PRADHAN, New Delhi.

"Entomology as part of Zoology Course:—In the study of Zoology we have to do equal justice to the whole of the animal kingdom and the animal kingdom consists of so many phyla and each phylum consists of so many classes; thus out of a very large number of classes the class Insecta is only one. The student of Zoology, therefore, can afford to devote a negligibly small portion of his time and energy to the study of Insecta, as from the pure knowledge point of view all classes are regarded of equal status and some times a single genus like *Peripatus* constituting a separate class is given more attention than the whole of the insect world. It is therefore absolutely impossible to do full justice to Entomology until and unless it is raised to an equal status to the rest of Zoology. As a justification for this suggestion reference may be made to the study of Metcalf and Flint (Destructive and Useful Insects) which graphically shows that the number of the known species of insects is many times larger than the total number of the rest of the species of the animal kingdom. Even from the purely academic point of view, therefore, it should not be regarded as being unjustified to demand an equal status for Entomology.

The Attitude of the Universities:—The next question is as to what attidude the Universities should adopt under the present circumstances, *i.e.* so long as Entomology is not raised to an independent equal status due to financial and other difficulties. In this connection I may refer to the practice followed at Lucknow. In this University, the provision is such that if a student decides in time to specialize in Entomology (also in other group) he is allowed one full year, after the Honours course to devote exclusively to the study of insects. In this year he is expected to specialize in insects for the M,Sc. degree, *i.e.* to make a general study of the various aspects of Entomology and thus to prepare himself for more intensive work in any particular problem. As to how far this practice is beneficial or otherwise this distinguished gathering can best decide, but as a student of the same system I may give my evidence that this is very useful practice. To be allowed to devote one full year to general Entomology before confining to any particular problem is very useful from the student's point of view, and if the other Universities encourage this practice they will be doing their duty at least in some measures, to this important science of Entomology.

Difficulties in Entomological Studies:—It is an absolutely established fact that due to the absence of reference collections Taxonomic work is an utter impossibility in most of the Indian Universities. The best way in which the Universities can serve this important science is by contributing morphological and physiological studies on the various groups of insects. Intensive morphological studies can prove of great help in determining the economic value of insects. The importance of the study of mouth parts has long been recognised in Economic Entomology, and the histological and physiological studies of the insect gut promise valuable results for the use of Economic Entomologist. The gulf, as a matter of fact, between the academic and applied aspect of Entomology is lesser than the gulf between pure and applied aspects of other sciences. It is therefore desirable that the Universities and research institutions should join hands and march to a common end. There should be only a simple division of labour so that pure Entomology may be tackled at the Universities and applied aspects in the research Institutions."

I expressed the above views in the Science Congress of January 1938, *i.e.* exactly twelve years ago. At that time I knew more about what was going on in the Universities and less about the Research Institutes. Now the state of my knowledge is just the reverse but still I do not have to change my views. If full use is to be made of the potentialities hidden in the study of Entomology the status of this subject has to be raised to that of other sciences. May I invite attention to a fundamental fact in this connection? The study of biological sciences has been dominated till lately by the idea of evolution. Most of us, therefore, were busy in either proving or disproving various trends of evolution. The basis of such studies was mainly morphological and from the morphological and taxonomic points of view the whole of the insect world come in just one of the five major classes of the phylum arthropoda which again constitutes just one of the twelve major phyla. From the economic point of view, however, we are more concerned with the physiology, bionomics, habits and the habitat of each organism and it is well known that in these aspects there exists far more variation than in morphology. There are physiological races in the same species. The same family of insects like Coccinellodae with closely similar morphological features contains species with such diametrically opposite feeding habits as make some species the best friends of humanity and others very bad enemies. Thus from the morphological point of view it is thought enough if we study any one species but this is not so from the physiological or economic point of view. If we want to apply our knowledge of animal kingdom to solve our economic needs then every species if not every race of each species should be given equal importance in our study. Judged from this criterion insects claim more than 2|3rd of a student's attention because out of about 916,000 known species in the animal kingdom there are about 640,000 species of insects. Obviously this is not possible unless the status of Entomology is raised to one of the major subjects.

APPLICATION OF GENETICS IN ANIMAL AND PLANT BREEDING.

(*Sections of Zoology, Entomology and Botany*)

DR. B. C. BASU, IZATNAGAR, Presided.

The opening address of Dr. P. Bhattacharya, Izatnagar was read by Dr. S. P. Ray Choudhury, Calcutta.

The ever-increasing seriousness of the world food position is now acknowledged everywhere. All over the world measures are being considered to increase crop production and to build up better livestock.

The science of Genetics can play a very significant role in improving the productivity of our plants and animals. It shows us the means by which one can transfer desirable characters, such as, high yield, drought resistance, early maturity etc, from one individual to another and so evolve newer varieties or breeds possessing a combination of a number of desired characters. On the crop side, in India as well as in other countries, valuable results have already been obtained. These will be dealt with by persons more competent to speak about them. I shall confine my remarks to animal husbandry side only.

The importance of the sub-continent of India as a producer of animal foods is apparent from her 180 million cattle, 50 million buffaloes, 46 million sheep, 58 million goats and 120 million poultry. The size of the livestock population is very imposing indeed, yet, in no aspect of nutrition perhaps shortages are so apparent as in high-grade, animal protein and fats. This is due to the well-known fact that the average productive capacity of Indian livestock is deplorably low. To quote a single example, the average production of an Indian cow is estimated at about 600 lbs of milk, which is about the same as that given by a good milch goat. As compared to this, the average milk yield of cows in Denmark is 7005 lbs, in New Zealand 5118 lbs, in U.K. 5576 lbs, and in U.S.A., 4126 lbs. This low productivity is no doubt due to their sad neglect in the matter of general health, nutrition and management. It cannot, however, be ascribed to these factors only. Sir Frank Ware mentions that by the introduction of better methods of management and scientific feeding, the milk yield of the village cow can be raised by 50% as a maximum. There are sufficient data available in the country to indicate that the chief limiting factor in the milking potentiality of Indian cattle is their poorer genetic ability. Whereas in U.K., there are cows giving over 38,000 lbs. of milk in a lactation, the ceiling for Indian cows has hardly exceeded 13,000 lbs., even in well-run herds as a result of forty or more years of intensive selective breeding. Permanent improvement in the present condition of Livestock would demand systematic improvement of the genetical make-up of the existing population through careful and intelligent breeding.

It will not be out of place here to briefly review some of the work on these lines carried out in this country and abroad and discuss the general principles that emerge from them. A good deal of work has already been done in foreign countries. In India, progress in this direction has been negligible. Some of the isolated efforts have, of course given valuable information. For example, in the military dairies, Departmental and Institutional farms cattle breeding work carried on a rational footing have yielded two very valuable results.

(*i*) Cross breeding suitable indigenous cows with sires of high yielding European breeds although produces immediate phenomenal results, yet, in the long run the method is beset with hazards, such as, deterioration in constitutional ability to stand the rigours of extreme climatic conditions and greater susceptibility to diseases.

(*ii*) Careful selective breeding within an indigenous breed is capable of augmenting production by three or four folds. Cross breeding Merino with Bikaneri has produced a valuable breed of sheep at the Hissar Farm—the Hissardale. The cross has not only improved the quality of wool but has also made possible such striking increase in wool yield as from 1½ to 7 lbs. In the Indian Veterinary Research Institute, an improved strain of Desi poultry has been developed which gives an average production of 140 eggs as against an average of 50, in village birds. At the Indian Agricultural Research Institute, a high-yielding, early-maturing strain of Sahiwal cows has been evolved through intensive selective breeding. At the Military Dairy Farm at Ferozepore, the daily milk yield of the Sahiwal herd has been increased from 5-6 lbs to 17-20 lbs within the period of twentyfive years by selective breeding. Recently, the Government of India have opened a Central Cattle Breeding Farm at Jubbulpore where work will be taken up on an extensive and planned basis for the development of better breeds of cattle. Many of the provinces and states have also planned schemes for scientific work on animal breeding.

As a result of analysis of Pedigress of record breaking cows the general conclusion has been made abroad that any system of breeding, except one, produces good results provided the parents are good: exception is close inbreeding. Some of the best animals have come from lines in which the degree of inbreeding has been reduced. Following the spectacular results obtained in the development of commercial strain of corn, excellent results have been obtained by crossing two in-bred lines of pigs in U.S.A. It has also been found that for getting the best results the in-bred lines have to be good in themselves. The problem thus reduces to finding out and using to the maximum extent the best breeding animals. While this is easy in case of products elaborated by both sexes, when we come to qualities such as milk yield, which is elaborated by one sex, the problem becomes difficult. On the basis of progeny tests, it is now possible to estimate the potential yielding capacity of males and institute comparison of males from different farms and ages on the basis of their, what are called, 'sire indicates'. As the process of arriving at such estimates takes time, it is essential that once a good transmitter has been discovered fullest use should be made of him. For this purpose the technique of artificial insemination offers the best solution. In India, though sporadic attempts had been made in the past to introduce artificial insemination, it is the planned work initiated at the Animal Genetics Section of the Indian Veterinary Research Institute which is chiefly responsible in making this a practical proposition under the difficult field conditions peculiar to this country. At the present moment 10,000 animals are being inseminated per year, on an average. at the four regional centres with six sub-centres covering an operational area of about one hundred miles in diameter. These centres and sub-centres are under the supervision and administrative control of the Animal Genetics Section of the Indian Veterinary Research Institute. As superior quality sires are being used for artificial insemination of cows the resulting progenies are genetically expected to be much better in their constitution and productive capacity. On a conservative estimate it has been calculated that when daughters of these bulls will come into milk a gain of 2,500,000 lbs of milk per year or a gain of Rs. 1,250,000 to the national wealth. The popularity of the technique amongst the villagers is on the increase. From 1946 to 1949 there has been a three fold increase in the number of cases treated at Patna, three fold increase at Calcutta and five fold increase at Bangalore. The average number of cows inseminated per ejeaculate has risen from 4.51 to 14.53 at Patna, from 5.32 to 12.47 at Calcutta, and from 2.56 to 7.31 at Bangalore. The highest number of cows inseminated per bull has increased from 384 to 1179 at Patna from 195 to 1015 at Calcutta and from 72 to 402 at Bangalore. Some provinces have also taken up the work and with extensive adoption of artificial insemination a way will be cleared for successful solving of the long outstanding problem of both paucity of good bulls and maximum utilization of proved bulls.

On the side of maximum utilization of the cows, recent work done at Cambridge, has shown a way. A cow normally produces a single ovum at each oestrum. When pregnant-mare serum hormone is injected, however, multiple ovulation is produced. Attempts are now being made to transplant the fertilised ova into other cows—one into each—and thus get a large number of offspring from the chosen mother in place of a solitary calf. Scrub cows, which we have in large numbers, could, thus, become virtual 'Incubators' of eggs of good quality cows. If this technique comes into popular use, a way will open to make increased use of good quality cows as well for quick improvement of cattle wealth.

Side by side with the problem of breeding the problem of infertility that faces the cattle industry in this country is a staggering one. It has been estimated that there are about 9 million cows suffering from one or the other form of infertility. Even if one million of them could be successfully treated. It would add a further 500,000,000 lbs of milk to the net annual production of milk in the country or add Rs. 250,000,000 to the national wealth. Results obtained by the workers at the Indian Veterinary Research Institute have shown the practicability of controlling infertility or subfertility in cattle in a large percentage of cases. In India, attempts at the manufacture of the P.M.S. and its field use was first undertaken at the Animal Genetics Section of the Indian Veterinary Research Institute. The products compare favourably with the costly patent products available in the market and has been used in the control of bovine infertility. Lastly, mention may be made of the use of Stilboestrol in the induction of normal lactation in barren cows and the use of Thyroprotein in augmenting milk production. Work on both these aspects have been carried out and have given good results.

With an increase in human populations there has been a relative steady rise in the number of domesticated animals. With the raising of living standards a necessity has arisen for heavier stocking of restricted areas of land and for larger and better yields from individual animals. From the foregoing remarks it will be clear that modern genetics provide ways and means of bettering both the condition and productive capacity of our livestock. A recent estimate by the F.A.O. of the nutritional 'targets' in the first class proteins needed by India to meet her growing requirements by 1960 places the figures 305% of prewar supply in the matter of meat, fish and eggs and + 60% prewar supply in the matter of milk (fluid equivalent). Provided that concerted measures are taken on an all-India basis and fullest use is made of the results available it should not be difficult to reach these targets.

DR. K. RAMIAH, Cuttuck.

He suggested to take help of statistics in the application of this branch of science. He pointed out that there is no provision for teaching genetics in Universities, except some arrangement in Agriculture Colleges.

DR. R. B. EKBOTE, Poona.

As an instance of practical application of Genetics to Plant Breeding I referred to the work of Breeding resistant strains of wheat for Central Provinces. The predominant rust is the black rust which is known to cause recurrent and large losses to the wheat crop. The breeding work was taken up under the auspices of I.C.A.R. A number of hybrid between Indian and highly rust resistant exotic wheats and it has been possible by means of application of genetical methods to evolve highly rust resistant hybrids.

DR. R. C. LACY, Patna.

Since the previous 4 or 5 speakers had omitted to mention anything regarding the "new genetics of Soviet Union as advocated by Lysenko based on the works of Lamarck, Darwin, Michurin etc., it was introduced so that the controversial claims may be settled by definite experiments.

The Indian geneticists were requested to try these methods as advocated by Lysenko which may prove beneficial to settle the controversy as well as may enrich the country by more production by quicker methods.

DR. N. PRASAD, Bihar.

An important aspect of Genetics has been omitted *i.e.* Genetics of micro-organisms particularly fungi provide a wonderful material for genetic study as they can be multiplied very quickly. Further the fungi are haploid while higher plants are diploid. Because they are haploid, the question of dominance does not arise. It is on this account, the fungi are suitable material for study.

The genetics of fungi has got a great fillip due to the discovery of Neurospora, Artificial irradiation with X'rays ultra violet rays, Y-rays etc has yielded strains with incapacity of manufacturing different vitamins. Proper crossing of these strains has yielded knowledge of the exact formation of vitamins and protein formation.

Study of genetics of plant pathogen like wheat rust, apple scale etc has yielded valuable knowledge to the plant breeders for improving their crops.

DR. A. P. KAPUR, Calcutta.

Dr A. P. Kapur pointed out that the fact that the Zoologist in India had neglected the subject of "Animal Breeding", was very apparent, since there was only one Zoologist who took part in the foregoing discussion. While he fully agreed with him as regards the scope of work and the potentialities of the science in the field of animal breeding, he feared that the story narrated by him was not complete. An important factor *i.e.* the effect of environments after the experimental stage of the work had been ignored. High milk yield in England and other Western countries was maintained on private and commercial farms because adequate amount of land and good sanitary conditions could be provided in those countries. In India too, a similar advance had been made possible but only on Govt. and military cattle farms. He doubted if a farmer in India could, under the present conditions, provide adequate grazing space and food for his cattle. Degeneration of high quality animals was bound to set in if adequate provisions are not made available for their maintenance.

Turning to the problems of genetics as applied to animals other than domestic, he stressed that no comprehensive work had been done in India. Botanists had studied the problems of plant resistance in relation to fungus and possibly virus diseases in India but similar problems in relation to insects and insect-borne diseases had been only indifferently tackled by them. Genetics could play a great part in the control of insect pests directly and by biological means *i.e.* by a genetical study of the parasites and predators of the pest.

DR. N. R. BHAT, Bombay.

The subject being 'Application of Genetics to Plant and Animal Breeding' it is important to know when and how exactly Genetics became applicable to plant and animal breeding. The rediscovery of Mendel's laws did not give any sort of guidance to plant breeding. It was important to know the genetical variability existing in any material. This was made possible only through the discovery of modern statistical methods by Prof. R. A. Fisher. Instances are not lacking of suitable work having been worked on material not having enough variability. Hybrid vigour in maize was not discovered through the knowledge of Mandel's laws. Even today we do not know which of the two theories for hybrid vigour, *i.e.*, (1) Jones' theory of accumulation of genes (2) the theory of hybridity by East.

As regards the "New Genetics" of Lysenko, it would give results as unstable as they would be quick.

DR. R. D. ASANA, Bihar.

Dr. Asana stated that he was associated as a plant physiologist with the plant breeding investigations in progress at the I.A.R.I., New Delhi.

He referred to the question raised by Prof. Lacy in connection with the new Genetics in Soviet Russia and pointed out that this concept laid particular emphasis on the developmental aspect in evolving varieties suited to different environmental conditions. This concept was quite useful but its rigid statement of several axioms was in question.

Referring to the physiological investigations in progress at the I.A.R.I., Dr. Asana pointed out that they were attempting to analyse the physiological factors concerned with crop yield as affected by draught, rust, nutrition etc. and this study naturally involved the consideration of the developmental phase. He further remarked that as a result of this study some promising indications had been obtained but as these were still of a preliminary nature he was not inclined to make any definite statements for the present.

The following resolution was passed unanimously:—

It was resolved that in view of the importance of the subject in increasing the Productiveness of the livestock and Agricultural crops in India the science of genetics should receive proper attention in the graduate and post graduate studies. It was further resolved that centres for the study of Animal and Plant Genetics be established in the country on the same line as in other advanced countries.

Dr. S. L. Hora, Calcutta.

While I am in agreement with what Dr. Pruthi has stated about the need of strengthing studies in Entomology in the teaching of Zoology in the Indian Universities, I differ from the last two speakers, Drs. Pradhan and Kapur, in the way they want Entomology to be taught in our Universities. Before I take up the points of disagreement, I wish to support whole-heartedly that teaching and research to be fruitful must go hand in hand and should not be divorced from each other. For instance, a Demonstrator may some time find a very striking abnormality of a structure in a common animal used for dissection. I would certainly suggest him to report upon it which will be Research arising out of teaching. Several important contributions have already appeared in India on such chance research problems.

Drs Pradhan and Kapur wish that the students in the Universities should be brought up with a bias towards applied Entomology. With this utilitarian aspect of teaching in the Universities I do not agree. The University should be fountain-heads of Pure knowledge and academic fundamental research should be their main objective. Like all other sciences, the science of Zoology has had two lines of progress-observations and Generalzation. No generalizations can be sound unless based on dependable accurate observations. The first need, therefore, is that our students learn to observe things for themselves and once they are capable of observation, application of the observed data to human problems will be a very ordinary thing. I would, therefore, suggest that zoological teaching should remain descriptive and observational upto the B.Sc. Honours standard and that if the candidates show special inclination towards Entomology arrangement may be made for its advanced teaching during the post-graduate period of a student's stay at the University.

It must further be borne in mind that any scheme or programme of work will have four main stages of development. These are:—

1. Descriptive Phase: Observations and codifiation of the existing knowledge.
2. Analytic Phase: analysis of the data collected.
3. Prediction and
4. Controls.

We cannot think of an applied bias represented by stages 3 and 4 above at the University stages but shall be happy to see the students well trained for making their observations and analysing the data. The institutes of applied research should then have an easy task in moulding the University products for the Prediction and the control stages.

Dr. D. R. Bhattacharya, Allahabad.

Dr. Bhattacharya traced the development of teaching of biological sciences for the last forty years. Various suggestion has been given to the Universities from the inter Universities board. Some lay emphasis on descriptive course others on comparative course. Already the course is too heavy and is difficult to finish it. Where we can add the subject now? We can not kill parents to bring up off-springs. Basic facts must be taught at the B.Sc. stage. At the Post-Graduate stage group study is being taken up as suggested by Dr. Hora. It may be recommended to the Universities for a three years B.Sc. course.

DR. H. R. MEHRA, Allahabad.

One should realize the difficulties of University education. What is actually required is proper type of teaching. Entomology is already included in the sylabus but proper teachers are wanting. If the standard of teachers is low that of the students can not be high. In the general course upto B.Sc. stage a student has to study Zoology and not Entomology alone. Good library and good teachers are essential. For this particular subject specialization should be encouraged after M.Sc. as in Cambridge etc.

DR. B. K. DASS, Hydrabad.

Entomology should be studied as a special subject at the M.Sc. stage and not at the B.Sc. stage. It is necessary to have basic knowledge at the B.Sc. stage. For a greater knowledge a B.Sc. (Hons.) stage of three years may be introduced after which specialisation for one or two years may be recommended. Importance should be put on the teaching of Physiology without which it is difficult to study real Zoology. Proper training of Entomology should be done at the M.Sc. stage.

DR. H. S. PRUTHI, New Delhi.

Dr. Pruthi in summing up the discussion pointed out that it may be noted that the house recognised—teaching of Entomology should receive more and better attention. As regards fundamental and applied bias Universities should not apply to applied bias as they have no time for it. They should restrict themselves to studies of fundamental as is being done at present. With regard to the scope of teaching Entomology and Entomological research in Universities we had to train workers for both the purposes;—one research (accademic) and teaching and the second objective to train research workers for applied jobs. If M.Sc. had proper training in Zoology they will do better in applied than Agricultural graduates because they know already fundamentals of Zoology. Similarly a B.Sc. in science do not know Agriculture so both lack for applied work. This statement is thus in agreement with those of Prof. Mehra and Dr. Hora. I agree with Dr. Bhattacharya and Prof. Dass with regard to specialisation of the subject in Post-Graduate stage. I would suggest the chairman may please appoint a committee to present a report to the next session how much Entomology is being taught at the school under-graduate and graduate stage.

Accordingly a committee of Drs. H. S. Pruthi, S. L. Hora, B. K. Dass, H. R. Mehra and M. A. H. Quadri with Dr. Pruthi as convenor was formed for the purpose.

The following resolution was unanimously passed by the Section of Entomology and Zoology at the 37th Session held at Poona in January 1950.

In view of the importance of insects in Agriculture, human and livestock health and in the development of some important industries it was resolved that special attention should be given to the science of Entomology in the teaching of Zoology in the Indian Universities.

It was further resolved that the inter university board and the education and Agricultural Ministry of the Govt. of India may be requested to communicate this resolution to the authorities of Universities and other educational and applied science institutions in India.

The following notes were received in connection with this discussion but could not be read for want of time and were accepted as read:

G. S. THAPAR, Lucknow.

Entomology has, in recent years, occupied a fairly prominent position in the University curriculum, especially in the post-graduate classes. This covers mainly the systematics, morphology and to some extent Physiology of Insects. Emphasis is also given to the damage done by insects to various food plants. In certain Universities, it forms a separate section of studies, with special appointments of Entomologists on the staff and reservation of examination papers on the subject.

I shall deal with that aspect of Entomology that has been gravely neglected and it is its bearing on helminthology. Entomologists were formerly paying attention mainly to the external characters of the insects for purposes of identification but more rececntly they have diverted attention to the internal structures as well. The examination of the interior of the insects has naturally revealed knowledge of helminth parasites, and their larvae. While there are a large number of insects that harbour adult nematode parasites, there are many that serve as intermediate hosts for helminth parasites of Vertebrates. The most important milestone in parasitology was the introduction of experimental methods in the study of Zoology and here we find brilliant work of Leuckart, leading to new lines of work in the life cycles of helminth. He (1867) by recording his observations on the development of *Protospirura muris* of mice in mealworms (*Tenebrio molitor*) demonstrated the role of insects as intermediate hosts and vectors of worm parasites. Earlier he discovered *Cucullanus* larvae from cyclops and suggested similarity in the mode of life cycle of *Dracunculus medinensis*. This was later substantiated by Fedschenks during his visit to Persia. Melnikon (1869) showed the development of *Dipylidium caninum* in dog flea, Manson (1878) observed the development of *Wucheria bancrofti* in the mosquitoes and thus established the role of blood sucking Arthropods as intermediate hosts of helminths. This was important as it resulted later (1898-1900) in the discovery of the relation of malaria and mosquitoes by Ross and Grassi.

Several other examples from helminths may be quoted, to show the role of insects as intermediate hosts of helminth parasites: *Cittotaenia* in Coleoptera, Lecithodendriidae (Trematode) in water beetles, *Spirocerca* of dog in *Blatta orientalis, Habronema muscae* in house fly, *Gongylonema* in cockroaches, *Onchocerca* in Simulium flies, *Setaria* in *Stomoxys Calcitans* and *Moniliformis* in cockroaches. Recent work on the life history of *Moniezia expansa* has brought into light a new group of Oribatid mites as intermediate hosts. Although Entomology at present occupies an honourable place in the Zoological teachings at the Universities, unfortunately there is no one working on this important group in India even to identify these vectors and we had to depend upon foreign investigators for it. This greatly hampers our work on the life histories. I would therefore strongly urge the necessity of diverting the attention of the Entomologists to this group as the occurrence of these mites are causing considerable damage to our livestock industry.

We find practically in all groups of Insects the intermediate hosts of helminths, and their knowledge is extremely essential to consider the control measures for the eradication of these parasites. Although a large number of Arthropods are involved as vectors for helminths unfortunately our knowledge of life histories is very limited. There are ample opportunities for co-operation amongst Zoologists in different fields in adding to our knowledge of the life histories of parasites, and little advantage has been taken of the possibilities of co-operation in this field. "The inter relationships of insects and nematodes is a subject of which entomologist seem to have little adequate conception." (Zwaluwenberg).

Even now we have several unsolved problems. One of the most important problem facing us to-day is that of humpsore of cattle due to the presence of a nematode, *Stephanofilaria*, where we need co-operation of Entomologists in finding out the transmitter of the disease to the animals. A competent worker should be able to see the possibilities of this co-operation. A sound consideration of the worm calls for a sound consideration of the host and in order to use prophylactic measures against worms we have to direct our attention to control measures of intermediate hosts and if this is an Arthropod a Helminthologist has to draw on the knowledge of a man who knows about it. An Entomologist can render great service to helminthology in the solution of the life histories if he would only call attention to the helminthological material he discovers in his usual routine work on the studies of insects.

Unfortunately animal instinct predominates amongst the leading Zoologists of the country and instead of helping and co-operating with each other they fight amongst themselves for Power politics. I only wish they exhibit more humanistic tendencies and a spirit of co-operation so that better progress may be possible in India's contribution in the field of Zoological research.

Dr. P. Sen, Calcutta.

Importance of entomology in an agricultural country like India can only be realised when one considers the colossal loss the insect pests can cause to the Agriculturists through damage to crops, damage to stored products and stored grains particularly where storage is necessary to avert famine conditions and in the present day rationed areas where large quantities of stores are held in reserve for the purpose of even distribution.

In a tropical country like India people are affected by insect-borne diseases much more than by any other kinds. Malaria is a common ailment in India. Plague becomes a threatening problem particularly in cities wherever congestion occurs as in Calcutta or Bombay.

Security of life and welfare of people to a great extent depends on the knowledge of insects and the role they play either as pests or as vectors of diseases. Thus of all the branches of Zoology, insects as a group stands pre-eminent both in diversity of forms and in economic importance.

Teaching of Entomology as a subject of study in the universities of India must offer equal opportunity for training minds like any other natural science subject. In the B.Sc. honours course an elementary course in Entomology should be incorporated for those who intend to specialise in this branch of Zoology. This course shall only contain theoretical and practical work on the structure and life-history of the insect together with the elements of systematic work.

In the post graduate course Entomology should be treated as a separate subject like Zoology and Botany.

Entomologists have to face problems which border on Botany, Chemistry, Bacteriology and other allied subjects, therefore the University teaching should afford facility for preliminary training in Bacteriology, Plant Physiology and Pathology, Biochemistry, soil Chemistry and some statistics. Arrangements for short courses will have to be made on these subjects while the student will be specialising in general Entomology in the post graduate classes. Such a comprehensive training for the students of Entomology is very essential since in the field of applied Entomology solution of complex problems arises involving a team work of scientific workers and unless the student has a preliminary knowledge on these subjects he is lost in bewilderment.

In the post graduate courses advanced morphology of the more important insect orders and advanced systematice work economic Entomology including ecology and field work should be included. Principles of applied entomology should also be dealt with. In the final year the students should be encouraged to take up a piece of research on an insect embracing details of a particular section and at the same time be conversant with the general biology of that particular insect.

This type of training will be a help in providing with men who can carry on research work independently in later life either as an agricultural Entomologist, medical Entomologist or general Entomologist.

It is equally important to open up a carrier for students with such a specialised training in entomology. A band of entomologist should be appointed in every province or state having agriculture forestry and health departments. It is unfortunate that very little is realised as to the scope of work awaiting an entomologist in all walk of life in a tropical country as ours.

Every university teaching Zoology and Entomology should have a separate professor of entomology and must be assisted by a Reader and at least two Lecturers. And as our universities are not always financially sound state must come forthwith generous contribution to augment such a training.

This discussion has gone from year to year since the Jubillee session of the Indian Science Congress Association at Calcutta, but unless Govt. takes up the question with the Universities and impresses on the University no finalisation of this can ever be expected. It is futile to talk when we have no power to put our deliberation into effect.

DR. K. B. LAL, Kanpur.

Entomology has been long recognised to be at least one of the most important branches of the Zoological science. During the last fifty years or more, the study of insects has overshadowed that of the parent science, both in volume and in the far-reaching significance of its results. This study has been greatly fostered by the developments in Agriculture, Forestry and Medical and Veterinary sciences and by the initiation of projects of public health, land reclamation and cottage industries, in all of which insects have been increasingly observed to play important roles. But apart from their economic aspects, insects have also provided valuable material for the scientific study of many basic problems of biology, ecology, sex, population, biometry, development, decay and death. Because of the beauty and diversity of their forms, accessibility, ease of capture, care and rearing, convenience of handling and storage as dead specimens and the comparative cheapness of the costs of undertaking all these persuits, insects have afforded the means of a most fascinating hobby to many men and women, not professionally or primarily devoted to Entomology. Less generally realised is the fact that insect study can be made to yield interesting results for improvements in human sociological conduct. Few have appreciated the enormous import of the old precept to the sluggard to go to the ant, study its ways and be wise.

There can, therefore, be no question of the predominant place of Entomology in the teaching of Zoology in the Indian Universities. No syllabus of Zoology can afford to treat insects merely as one of the Classes of the animal kingdom on a par with others. Unfortunately, this has been the prevailing practice in the Indian Universities. It appears that even the conventional representation on the basis of population so attractive to politicians—has not been accorded to the subject of Entomology. It has been claimed by more than one authority that the estimated number of insect species and individuals are far greater than those of all the other animals put together, and the claim has not been disputed. Another tendency that has been manifest of late has been to consider Entomology merely as an applied science and to believe that application can be properly learnt or taught without an adequate understanding of the bases that govern that application. As a result, insect morphologists, physiologists, ecologists, embryologists and systematists have been far fewer than economic entomologists. The correct appreciation of the place of Entomology in the teaching of Zoology should lead to a far greater abundance of the former than of the latter. Economic entomologists would of course always be numerically greater than those who study the purely scientific aspects of the subject but the present disparity in the relative importance attached to the two and even in the numbers between the two is not desirable. In considering the place of Entomology in the teaching of Zoology this lopsidedness should be borne in mind.

DR. D. P. RAI CHOUDHURY, Berhampore.

The importance of Entomology in the teaching of Zoology in Indian Universities cannot be overemphasized. In fact, it is at present reckoned to be so very important that Colleges and Institutions in advanced countries like U.K. and U.S.A. arē having well equipped separate Departments of Entomology, giving particular attention to the applied side of the subject so that country's hygeine, commercial and food problems may be tackled properly.

I need not go into these in detail as, I daresay, almost all the relevant points will be brought up during discussion when the subject will be opened up for discussion by Dr. H. S. Pruthi.

I would conclude by saying that in independent India immediate earnest steps should be taken to give Entomology, particularly applied Entomology, its due place in the teaching of Zoology in Indian Universities so that India may progress hand in hand with other advanced countries in Agriculture, Horticulture, Animal husbandry, Commerce and Industries. Perhaps the best procedure would be to send a befitting memorial to the Ministry of Education, Government of India on this subject through the Indian Science Congress, Poona Session, 1950.

DR. H. D. SRIVASTAVA, Izatnagar.

In recent years there has been a growing appreciation of the importance of Entomology in relation to medical and veterinary sciences and the productiveness of Agriculture forestry, sericulture, lac and bee-keeping etc. In consequence, certain Universities have introduced a special paper in the subject for the M.Sc. degree in Zoology. Entomology is such a vast subject that the study of the arthropods in general courses in Zoology is not adequate and to most University students it does not mean anything more than the morphology and life histories of certain arthropods. But the ultimate object of studies on morphology, taxonomy, life histories, bionomics and distribution, correlated with data on climatology and topography, etc., should be to increase the productiveness of useful arthropods and to reduce the losses occasioned by the harmful ones. To this end, it is essential that the student specializing in Entomology should have a sufficiently comprehensive concept of the subject, including its bearing on medical and veterinary sciences.

In submitting a plea for a special course in Entomology in the post-graduate classes in Zoology of Indian Universities, I shall not refer to its obvious importance in agriculture and forest produce or in medical or in veterinary sciences, but rather to its bearing on the control of a large number of important helminth parasites which seriously affect the health and usefulness of man and his livestock. This neglected aspect of Entomology presents problems of intense scientific interest and great importance to the welfare of man. In the life cycles of a large number of these parasites arthropods serve as intermediate hosts, and in order to be able to formulate rational control measures against the former it is necessary to have a sound basic knowledge of their biology. The Universities in drawing up their curricula for post graduate classes in Zoology should pay special attention to the provision of adequate basic instructions in Entomology. This is essential to meet the present dearth of Zoologists with the requisite basic knowledge of the subject to conduct research in the different aspects of applied Entomology.

DR. P. J. DEORAS, Poona.

The application of Zoology to Human Welfare and economics has been justly exemplified by its utility so well brought about in the last war and the demand that has been created after the war. Two main factors that influenced the course of the war, though indirectly amply put Zoology particularly applied, Zoology in the forefront of our well-being, these being-the silk that made the parachutes and DDT that won the war on the epidemic front. Thus Entomology has come to mean a lot, and the present drive for food has given it a bit more of an importance.

A student that takes Physics and Chemistry or even Maths and takes his degree has apart from the various chances in life some hope of being absorbed in industry. Our biology students after their B.Sc., may take to M.Sc., or the routine change over, but they hardly had any chance in industry. This state of affairs is fast disappearing, and there has been a demand for Entomologists of recent times. Unfortunately in our Universities the subject of Entomology so far meant only the Agriculture faculty, or more curious instances could be cited where a person qualified as an Entomologist after his M.Sc. was thought to be alien to Zoology, and one could give instances where such persons were hounded out of the field of Zoology. This state of affairs will slowly change. A statistics of the specialists in the various branches of Zoology would show that quite a lot of them have taken Entomology, because it was more paying. Unfortunately these scientists left the universities for their profession and the training of the next generation was again left where it was. Of recent years Fisheries, Protozoology, Helminthology, and Mammals are attracting some students but so far the number of Entomologists remains unchallenged.

Noting the importance of Entomology, the I.C.A.R. had given certain grants to Universities and sought to establish schools of research at the various places. Unfortunately there has not been much response to this, and the results also have not been very encouraging. It is therefore desirable that some addition has to be made in the University curricula and students attracted to the same, later in the post-graduate classes specialisation is to be done not only from the reseach point of view, but a stress on the actual practical aspect and utility of the subject to the student. In the Intermediate classes the students be told of the various economic aspects of Zoology and the different opening the subject would offer to the student. In the B.Sc. classes he chooses, or is guided to choose one of the subjects of economic importance, and is properly coached in the same. Here the students if they choose Entomology are taught the Morphology, Physiology, Classification, and a line of special study according to his aptitude. A student may take Plant-Protection, Toxicology, Public health Entomology, Apiculture, Sericulture, Systematics, or General Entomology. When the student has taken his B.Sc., degree, he would have had a basic grounding in Entomology. He can if he likes take to his M.Sc., either by a thesis, or by papers in the special branch of his choice. Such a student after B.Sc. would be a welcome candidate in Industry; a newly developing group dealing in Insecticides. There is a great demand for such graduates, but very few are available. Thus we would give our Zoology graduates an outlet in Industry. After his M.Sc. he is really well qualified and would be an ideal candidate in an University, or for further higher research. In the case of students taking their Agriculture, Veterinary, or Medical degree, some more time be spent on the fundamental principles of Entomology.

These groups could specialise in their own fields, but without a basic training in general Entomology they are at a loss to deal with the problems. It is needless to say that for all research the candidates that could be best suited would be those that have had a proper training at the University. If we have a student who has a training in Entomology on the basis lined above, he should certainly be prefered to the one that has had a part training only. An M.Sc. with this kind of work and specialising in Plant Protection may be better than a B.Sc. (Ag) with equal number of years of training.

Entomology as one of the very paying aspects of Zoology should be given a proper place in the curricula at the Universities, and students turned out that are in great demand for the National welfare.

SYMPOSIUM ON

"MEDICAL EVALUATION OF NUTRITIONAL STATUS"

(Jointly with Sections of Physiology and Medical Sciences)

OPENING REMARKS: DR. K. MITRA, (New Delhi).

No apology is needed for holding a discussion on "The Medical Evaluation of Nutritional Status". The unpleasant truth is that the term 'nutritional status' has not yet been defined properly inspite of all our researches in medical sciences. Broadly speaking, however, in individuals, who have not crossed the clinical threshold, or are not suffering from any apparent disability or risk to life, the nutritional status is almost synonymous with his or her state of health. But this definition also is vague and nebulous. Does the 'state of health' or 'nutritional status' imply physical fitness and exclude the mental intellectual or social fitness. Leaving the implications of mental and social fitnesses severely alone, the opinion on the subject of health and physical fitness, to say the least is extremely mobile beginning from the era when the empirical art of treatment was first initiated by the 'magic man' or 'medicine man' of the primitive society, till about the revolutionary discovery of bacteriology in the last quarter of the last century. Very little attention if at all was paid by medical or public health organisations to persons who were not clinically ill or were not suffering from any bodily ailment. Probably many decades would pass before we can hope to demarcate and grade the various degrees of health, nutrition or physical fitness in an apparently healthy individual. The problem at issue is what constitutes the physical fitness or the phenomena of health. Certainly it is some physiological condition. Human body is a complicated machinery as far as its physiology is concerned and the total quantum of health is associated with the integrity and potentialities of the physique, organic efficiency and motor and sensory fitnesses. In our search for yardsticks of measure for the efficiency of any of the three phenomena enunciated above we have to depend upon some or a few of the physiological indexes associated with them. It is very good to talk of healthy and robust appearance, muscular development, good posture, normal bones and joints, good size for age etc. in a systematic appraisal by medical inspection, but it is very difficult to measure quantitatively the various phenomena mentioned.

The same remarks apply to organic fitness. If there is some visible defect in the normal sense-organs of sight, hearing, smell, taste, feeling and should a person be considered unfit as far as his physical fitness is concerned or should the principal point then at issue be the degree of fitness of his heart and circulatory system and whether he possesses marked resistance to cardiovascular fatigue. The fitness of glands, internal scretions, digestive system etc. also come within the purview of organic fitness.

Considerable confusion exists over attempts to over simplify the concept of physical fitness. We do not for a moment presume that there can be one or two indexes discovered later on which would determine the physical fitness or state of health of any individual under examination. But certainly with sustained efforts some indexes or groups of indexes with arithmetical computations could be suggested which when applied scientifically may yeild some information.

Apart from the above, in individuals likely to be employed in the industries an important element in the efficiency of performance is the precision for mechanical skill in movements. This brings in the question of neuro muscular efficiency apart from oxygen debt capacity.

It is quite natural to visualise that different standards of various sets of physiological phenomena would have to be described for persons taking to different vocations in life may be in the home, office, or agricultural pursuit in the field, light or heavy manual labour in industries or hard, arduous, hazardous life in the defence services of the country. Of course still more rigorous standards may have to be reached by athletes and performers of physical feats, but these are outside the purview of this discussion.

It is now an accepted fact that percentage incidence of deficiency diseases like xerophthalmia, stomatitis, incipient scurvy, phrynoderma etc. do not indicate the depth or degree of lowered nutrition, but certainly they have a bearing and cannot be completely ignored. We know that with the help of this symposium we would not be able to solve to any great extent the zigshaw puzzle presenting before us but the need for standards may be increasingly realised by such discussions.

Apart from the administrators who often want to know in these days of food shortage, the measure of nutrition or mal-nutrition in groups of people, the scientific workers must have realised by now, that crude yardsticks of measure of height and weight averages certainly could not always give an indication as to the comparative nutritive value of food supplements. This aspect of the question deserves certain amount of attention at the hands of the nutrition scientists. The present symposium is just one of the many that may take place in future to discuss across the table the views and experiences of scientists who may have worked or are pursueing certain aspects of the problems on health and nutrition.

DR. V. N. PATWARDHAN (Coonoor).

The application of biochemical methods for the evaluation of nutritional status has been a refinement over the older methods of clinical appraisal.

It is widely accepted that morphological changes succeed alterations in the composition of body fluids and they in their turn are followed by impairment of function. If in this chain of events one can detect with certainty the alterations in the composition of body fluids due to malnutrition, it will certainly assist in being able to prevent the process from going further. In countries like U.S.A., Canada and United Kingdom, great stress is laid on these subclinical deficiency states and their detection, for in these countries primary nutritional deficiency as manifested clinically is so scarce as to be a rarity. Whereas in India and in several countries of the East, the detection of subclinical deficiency states remains merely an academic problem owing to the overwhelming incidence of frank deficiency disease.

The states of nutrition have been classified at various times in several grades by several workers. These classes vary according to the outlook of the author and his mode of attack on the problem. I shall describe only two of them here. While both classifications are based on almost identical concepts, there are some differences between the two.

Dann and Darby classify the grades of nutritional status as follows:—

(*a*) Saturation.
(*b*) Unsaturated but functionally unimpaired.
(*c*) Potential deficiency disease.
(*d*) Latent deficiency disease.
and (*e*) Clinically manifest deficiency disease.

Sinclair on the other hand prefers the term 'nutriture' to the rather longer counterpart 'nutritional status', and classifies the different states as follows:—

(*a*) Excess nutriture.
(*b*) Normal nutriture.
(*c*) Poor nutriture.
(*d*) Latent malnutriture.
(*e*) Clinical malnutriture.

The "state of saturation" of Dann and Darby is not necessarily desirable. It may even be inadvisable to saturate the body with nutrients like fluorine and vitamin D which then would give rise to toxic manifestations and thus the conditions qualify for inclusion in the "excess nutriture" category of Sinclair. Probably the former authors intended to convey normality by the term saturation.

Normality is hard to define. In any biological characteristic there is considerable variation and by normality we mean that any given value will fall within the range observed in a large number of normal individuals. Owing to this difficulty single determinations do not help to obtain an idea of nutriture of any given individual; on the other hand, single determinations on a number of individuals may indicate with greater certainty the extent of deviation from the normal mean and thus help in the assessment of nutrition of population groups. So far as an individual is concerned repeated studies only can yield information of any value.

Whichever classification is used it should be clear that the biochemical methods are only applicable at the stage where the body reserves may be depleted or composition of body fluids altered. This may correspond to stages intermediate between classes 3 and 4 of Dann and Darby and also of Sinclair. Although the composition of body fluids is altered in the clinically manifest stages of malnutrition, their determination ceases to be of importance in the evaluation of nutritional status.

The biochemical assessment of nutriture depends upon the alteration in the composition of body fluids with respect to (*a*) the nutrient itself, (*b*) some component whose concentration is influenced by the lack of a particular nutrient or (*c*) a metabolite which may (*i*) appear *de novo* or (*ii*) merely accumulate in higher concentrations due to disturbed metabolism.

An attempt was recently made by us at the Nutrition Research Laboratories to evaluate the nutritional status of adults and children with respect to thiamine and riboflavin. Since all the limitations were probably operative for both these vitamins, I propose to describe in brief our experience in the matter (Rama Sastri, Mukunda & Patwardhan).

The investigations dealt with (*a*) 24 hour urinary excretion of thiamine and riboflavin (*b*) response to load test and (*c*) fasting one hour excretion. In addition, for the evaluation of thiamine nutriture, pyruvic acid and lactic acid determinations on blood were also done wherever possible.

Fifteen normal adults were kept under observation and altogether 98 observations were made. Large variations were found in the proportion of ingested thiamine appearing in urine, the range being between 8 to 63 per cent. The excretion of the thiamine seemed to have little relation with the intake within the limits studied. It is not possible, therefore, to arrive at the estimate of adequacy by this method. The response to load test was similarly inconclusive. These results therefore show that no definite conculsion can be arrived at by either a single determination of thiamine in 24 hour samples of urine or by load test.

It was found that the urinary excretion of riboflavin sometimes exceeded the intake. This has been repeatedly observed and the reason for this discrepancy seems to be in the composition of the diet with regard to the levels of fat and proteins. When both are low the urinary excretion is higher. This fact will therefore have to be taken into consideration in trying to assess riboflavin nutrition of subjects in India where diets are usually poor in fat particularly and not infrequently in protein as well.

The load tests with riboflavin performed on eight adults also suffer from the extreme variability of response with an almost complete lack of relationship between it and riboflavin intake.

In conclusion it can be said that much work remains to be done before the results of excretion studies on riboflavin and thiamine in urine can be usefully interpreted for the evaluation of nutriture with respect to these vitamins.

COL. O. P. VERMA, (New Delhi).

In the Armed Forces, as you would realise, it is extremely important to know the state of nutrition of the fighting soldier before exposing him to the stress of operational conditions. It is paramount that a soldier should not only be fit but "fighting fit" under conditions of battle otherwise he will soon be a casualty and will require evacuation to the base area. It is, therefore, a necessity that every soldier must have as much nutritional reserve in his body as possible.

Assessment of this state of nutrition as has been pointed out earlier is very difficult. In the clinical assessment, it is impossible to spot out deficiencies until definitely established. With the biochemical methods as the range between the normal, minimum and maximum is wide, it is difficult to assess an individual's "saturation state" if I may call it. Such methods are more useful for groups rather than individuals.

In the army, however, an individual is as important as the group as any individual can be a serious menace to the whole group when the stress comes. The Armed Forces, therefore, employ physical efficiency tests in addition to the clinical and biochemical tests in the case of all soldiers. The physical efficiency tests are more or less fatigue tests. Every soldier after sufficient training and if adequately fed is expected to do sufficiently hard work with reasonable efficiency and time. On this basis tests have been devised which consist of going over difficult obstacle courses with full equipment in standard time without being unable for further work immediately afterwards. The results of these tests are sufficiently interesting and useful.

MAJOR B. D. P. RAO, (Poona).

In addition to measurements such as height and weight in relation to age and body surface, certain biochemical estimations are also of value such for example as the

Haemoglobin content of blood and plasma protein levels. The usually employed method for estimating haemoglobin, namely Sahli's, is not very reliable as the coloured standard fades with time. The alkaline Haematin method is recommended. In the case of plasma proteins estimation, the copper sulphate specific gravity method of Vanslyke and others is not very accurate. This method is quite satisfactory for estimation of serum proteins as opposed to plasma proteins.

CONCLUDING REMARKS: DR. M. V. RADHAKRISHNA RAO, (Bombay).

In view of the importance of the subject under discussion this question was thoroughly discussed by a special Sub-Committee appointed by the Nutrition Advisory Committee of the Indian Research Fund Association quite recently. In order to give a lead in this direction, the Sub-Committee drew out a proforma for the use of nutrition workers in this country.

Although the subject is of great importance, we have no definite criteria—either clinical or Biochemical—to positively assess the state of nutrition in large population groups. These yardsticks for measuring the state of nutrition varied from country to country, and perhaps from place to place. During my recent visit to the United States, I had an opportunity of discussing this question with the leading nutrition workers in the States, where advanced Biochemical methods have been employed to detect subclinical nutritional deficiencies. In a country like the United States, where gross malnutrition or undernutrition is rarely evident, resort had been made to Biochemical methods for detecting nutritional deficiencies. Even then, the matter of diagnosis of deficiency states appeared uncertain, as the normal range of the various nutritents in blood, as also the minimum level of these nutrients below which deficiency symptoms manifest themselves, are not yet definitely understood.

In a country like ours, where, there is overt malnutrition and undernutrition, such Biochemical methods may not be necessary for the present to assess the state of nutrition. Resort has, therefore, still to be made to certain well-established clinical signs and symptoms in assessing the state of nutrition in population groups in this country. I congratulate the Nutritional Research Laboratories, Coonoor, for having initiated the work in connection with the studies of Pyruvic acid, lactic acid and Riboflavin levels in normal human beings. But one is inclined to believe that inspite of whatever has been done in the field of biochemistry the clinician still holds the field, in the detection of gross malnutrition or under-nutrition, and in the medical evaluation of nutritional status, as far as our country is concerned.

SYMPOSIUM ON RICE

(Organised jointly with the National Nutrition Association of India)

OPENING REMARKS BY THE CHAIRMAN: DR. K. MITRA, (New Delhi).

Rice which hardly received any notice during discussions in polite circles as recently as a decade ago is very much in the news today. On occasions more than one during the recent years, this foodgrain has been the subject matter of anxious and at times heated debates both inside the legislatures and outside. The reasons for such an extraordinary attention that this unpretentious grain has been receiving recently from the politicians and the administrators are: (*a*) Rice is the staple article of diet in a very large part of India (*b*) the production and distribution of rice is intimately associated with the economic life of many millions in this country and (*c*) it is said to be in short supply.

It is the staple article of diet for the majority of people notably in Philippine, Japan, China, French Indo-China, Malaya, Indonesia, Thailand, Ceylon, India and Pakistan. It was estimated a few years ago, that out of about 96 million tons 91 million tons of rice are produced in these countries alone. The biggest producers being China 37% and India coming next with 27% of the total world production. In our country rice is undoubtedly the most popular cereal followed by great millet (Sorghum vulgare) and wheat in order of the total tonnage produced. The word (annam) is synonymous in Sanskrit with cooked rice and food. In a few of the Indian languages it is usual to enquire whether one had 'taken his rice' in order to ascertain whether he has taken his food. Similarly it is said that in Classic Chinese the term for "agriculture" is "rice culture".

Nobody knows in which part of the world rice was first cultivated but it is justifiably presumed that rice as a food crop was grown for the first time in some parts or the other in South East Asia and was certainly known in India and China at least 3,000 years before Christ. The cultivated species of rice number several thousands. In Sushruta Samhita which is supposed to have been codified more than 4,000 years ago, no less than 15 verses have been dedicated to describe the various qualities and properties of rice as food. The usual types of rice kernels possessing reddish brown colour and pale colour has been described. The colour of certain grains has been likened to white lilies and even shape of the grains in one species has been likened to the head of the buffalo. The names of species possessing fine flavour have been described and even to a and a few others even the fragrance of flowers has been attributed. Such detailed descriptions indicate that a good deal of diligent study and observations were carried out on the different types of rice cultivated in India in ancient times. Through the old literature of the rice eating areas in India we obtain glimpses of culinary art practiced on cooking of rice in the form of different palatable dishes.

Unfortunately in the rice eating tracts of the world mostly confined to Asian countries malnutrition reigns supreme. But how much of the prevalent malnutrition is due to the poverty of the people resident in such countries and how much of it is due to their rice eating habit is very difficult to answer in the present stage of our knowledge. In other words it is yet to be known how far rice *per se* is responsible for the lowered state of health of its consumers. Wheat has been described by some of the Western authors as being the food of the blue-blooded nations in this world and by some as the king of cereals. Time alone would prove whether such a presumption in favour of wheat can be substantiated by scientific findings. There is no doubt that *prima facie* evidence from table of food values tends to categorise rice as an inferior cereal but the recent findings on the biological value of rice protein have been revealing enough. A deliberate mention of this issue is made as a tendency has been noticed amongst certain sections of the more informed groups of people in this country to [illegible] down upon rice and rice diets. One must not ignore the fact that with rice as the basic cereal the national dietary can be as well balanced as with any other cereal, as the basic food. It is the quality of other constituents of the rice-,wheat—or maize-diet which determine ultimately its balance or unbalance. Probably rice has one advantage over wheat from the poor man's point of view, in that rice grains in edible form keep longer than wheat flour, needs lesser care during transport and can be cooked easily with the help of any non-descript pot over fire and eaten. Knowing that rice is so intimately associated with our national life it is desirable to place the knowledge during the recent years at the disposal of the people. Quite a volume of work has been carried on the biochemical, nutritional and culinary aspects of rice as food and this symposium has been arranged by the Indian Science Congress jointly with the National Nutrition Association of India to collect the existing store of knowledge on rice with contributions from experts in different aspects of the rice problem.

THE RICE ECONOMY OF INDIA

Mr. R. L. Sethi, (New Delhi).

As the staple food of more than half of the human race, Rice is the most important of the cereal of the world. In point of acreage and total value of production, rice ranks foremost in Indian agriculture. India produces more than a third of the world's crop, which is second only to China's. In this country the acreage under rice forms 31.6% of the cultivated area and the annual yield amounting to about 20 million tons equals more than a third of all the food crops. It is the most important crop in the maritime provinces of Bengal, Orissa and Madras as well as in the contiguous areas like Assam, Bihar and the U. P.

In spite of all this, India was never self-sufficient in her rice requirement even before the last decade. On the other hand her rice economy was dangerously marginal and made-up invariably by heavy shipments from Burma.

Rice trade; gross exports and imports of India

(Pre-partition)

(Cleaned rice in .1,000 metric tons)

		Imports			
	Period	from Burma	Total	Exports	Retention
Avg.	1911—15	703	854	568	286
	1916—20	1,044	1,180	312	868
	1921—25	740	879	331	548
	1926—30	975	1,088	306	782
	1931—35	1,569	1,636	245	1,392
	1936—39	1,649	1,724	282	1,442

(Wickizer & Bennett. The Rice Economy of Monsoon Asia. 1941—pp. 324-25).

The fact, Burma was all along the mainstay of rice supply, whenever crop failure results in rice deficit in India. This complementary nature of the Burmese and Indian rice economy as supplier and consumer, was responsible for making the dangerous deficit rice economy of India, after the partition of Burma (1935). Since then further partition of the country to Pakistan (1947) left Indian Republic with 78% of the undivided India's population predominantly rice eating, with only 72.5% of the undivided India's rice lands. On an average (of 1936-46) about 20.54 million acres on rice lands yielding about 7.5 million tons of rice per annum have been lost to Pakistan.

To make matters worse, our rice production has always been erratic. There were great fluctuations even during the last 12 years with which we are immediately concerned, the acreage ranging from about 54 million (in 1941-42) to about 61 million (in 1946-57. Production range was much narrower, from about 16½ million tons (in 1940-41) to about 21 million tons (in 1943-44).

ACREAGE AND PRODUCTION OF RICE IN INDIAN UNION

(in reporting areas only).

In millions

Years	Acreage	Production in tons	
1936—39	54.961	19.451	
1939—40	55.335	18.432	
1940—41	54.801	16.576	
1941—42	53.993	17.343	
1942—43	55.556	18.107	
1943—44	58.635	20.846	(highest yield)
1944—45	60.080	19.771	
1945—46	58.013	18.208	
1946—47	60.987	19.856	
1947—48	60.818	19.584	
1948—49	60.480	18.863	

The fluctuations in rice production was generally traced to unfavourable seasonal and climatic factors or the abnormal incidence of pests and diseases which had been almost a characteristic of Indian rice agronomy throughout the last decade.

Considering the consumption requirement of rice and the availability of the local produce, imports are necessary to bridge the gap.

Estimated production of milled rice available in Indian Union and estimated human consumption.

(In 1,000 metric tons)

Years	Production	Years	Consumption
Pre-war	16,700	Pre-war	18,325
1947—48	16,900	1948	17,791
1948—49	17.500	1949	18,564
1949—50	18,100	1950	19,364
1950—51	18,800		

(Report of the Rice Committee Meeting, Baguio—pp. 34 & 36)

The gap between production and consumption carried on from pre-war times has not only been retained but in recent times there is also a dangerous widening of the same. To bridge the gap between production and consumption, the Republican Government has been progressively increasing rice imports in recent times at heavy costs.

Import of rice on government account into Indian Union (Indian Food Statistics pp. 43A)

Years	Quantity in 1,000 tons
1943—44	193,8
1944—45	426,3
1945—46	575,0
1946—47	817,8
1947—48	791,2

This salient factor has, however, to be measured against an increasing population, a considerable proportion of which are rice eaters.

In as much as the world production and consumption of rice are heavily concentrated in Asia, the pressure of population on the land is greater than any other area of the world of comparable size in the case of the three largest rice producing countries of the world, China, India and Japan. For decades before the war, population of these countries had been increasing at a faster rate than the production of their basic food, the rice grain, as shown below:

TREND IN RICE PRODUCTION AND POPULATION IN ASIA
(Rice Bulletin 1949 P. 46)

Six year periods	Rice production	Population	Production per person
1921—25	100	100	100
1926—30	100	106	94
1931—35	106	113	94
1936—40	107	120	89

Indian population before 1872 (the year of the first census) though imperfectly known, is understood to have grown fitfully and passed through periods of stagnation and decline. Between 1872-1921 the population of undivided India (excluding Burma) increased by only 19% or an average annual rate of less than 0.4%. But during the last 20 years (1921-41) the Indian population has increased at an average annual rate of 1.2%, or more than three times as fast as in the previous part of the Indian census history. The production of rice has not in any way been keeping pace with the increase in rice eating population as revealed in the following figures.

Changes in Rice position in India undivided for 5 year periods from 1916—1940
(Wickizer & Bennett. Rice Economy of Monsoon Asia—pp. 328).

(In terms of cleaned rice per million metric tons).

Period	Production	Imports	Exports	Available supplies	Population in million	Per capita utilisation.
1916—20	28.11	1.20	0.34	28.97	308.2	94 Kg.
1921—25	26.67	0.89	0.29	27.27	311.2	88 ,,
1926—30	25.87	1.10	0.31	26.66	328.6	81 ,,
1931—35	27.13	1.48	0.26	28.35	346.4	82 ,,
1936—40	25.77	1.73	0.33	27.17	363.5	75 ,,

(Wickizer & Bennett. Rice Economy of Monsoon Asia—pp. 328).

Our decreasing home production and limited and regulated imports have caused considerable reduction in our per capita consumption of rice engendering widespread ill-feeding.

The Grow more Food Campaign during the 3 years (1946-49) has not substantially added to our total food production, although over 16 crores of rupees were spent by the Central Government during the period on loans and grants. The actual achievements reported are, the distribution of 7 million tons of organic and inorganic manures, 0.3 million tons of seeds and digging of nearly 50,000 wells. That the efforts towards increased production has not borne fruit is evident from the fact that total production of rice has not only shown any increase but has even shown a decline.

Acreage and production of rice in the Indian Union during 1946-49 (in 1,000).

Years	Acreage	Production in tons
1946—47	60,987	19,856
1947—48	60,818	19,584
1948—49	60,480	18,863

(Estimates of the Area and yield of the Principal crops in undivided India—pp. 28 & 29)

Before the partition of the country (in August 1947) the Government had formulated a five year plan (for 1947-48 to 1951-52) which envisaged an increase of four million tons in the production of our foodgrains; and the bulk of the increase was to be in rice. After the partition, the target was necessarily reduced to 3.2 million tons. The success of the five year food drive, which is now under way, will depend largely on the import availability of certain production requisites like tractors, bull dozers, fertilisers etc. The Government has also planned for land reclamation and jungle clearance, which will add about six million acres to the total area under food crops and yield about 2 million tons of additional foodgrains a year. Though it may take about 10-12 years, before all the project including multi-purpose water control, are completed, it will assure a regulated supply of irrigation water to some 18 million acres of arable land and increase food production by about five million tons a year.

Now I will briefly discuss the possible remedies to meet the deficit and see how far the announced programmes and policies of the government can fit into it.

(*a*) *Increased Cultivation.*

The immediated solution to any food problem is manifestly intensive production, extensive cultivation and better conservation of the produce. The productive capacity per unit area in India seems to be the lowest in the world as shown in the following table.

Comparative average (for 1936-37) yield per acre of rice in the principal rice growing countries of the world.

Countries	Yields in lbs per acre	Index Nos.
Spain	2,631	357
Italy	2,442	331
Japan	2,352	319
Egypt	1,902	258
U.S.A.	1,657	225
China	1,534	208
Siam	882	120
Pakistan	817	111
Burma	816	111
INDIA	738	100

Futher, as the following table will also show, if the yield of Japan and Egypt are progressively increasing, that of India is progressively decreasing year after year.

Average yield of paddy in specified countries (Production in Quintals (220.46 lbs) per Hectacre (2.47 acress).

Countries	Average of 1934-38	1946	1947	[illegible]
Spain	62.3	42	41	[illegible]
Italy	52.8	417	[illegible]	[illegible]

Japan	36.3	36.9	35.9	40.3
Egypt	35	35.4	39.1	37.6
China	25.3	25.2	25.3	25.2
U.S.A.	24.7	23.1	23.3	—
Pakistan	14.8	14.4	13.7	13.7
Siam	14.3	12.7	12.6	12.6
Burma	14.1	12.7	14.1	—
India	13.1	12.3	11.8	—

Inadequacy of water supply is the factor most seriously limiting rice production in India. India's rice crop is almost entirely dependent on monsoon. An adequate water supply for irrigation is guaranteed only for a quarter of the rice land. The area under irrigated rice in Indian provinces was only 18.393 million acres in 1943-44 against a total rice acreage of 53.693 million acrea.

Since many of the irrigated areas are supplied only with innundation canals and tanks, water may not be available to the crop at the critical period of its growth. Adequate reservoirs in the canal system and wells and pumps are needed to improve the water supply even in irrigated areas. The total new area that will be irrigated by the proposed major irrigation projects like Tungabhadra, Ramapadasagar, Krishna-Pennar, Hirakud dam, Damodar project, Kosi and Bhakra dams and other provincial schemes when completed would be more than 27 million acres. This is a substantial figure against our total irrigated area of less than half a million acres; but against our total cultivated area of 185 million acres, it is not much.

(*b*) *Improved seed.*

Early maturity is a valuable character which can be achieved by breeding; such varieties have also been found to give generally better response to manuring and irrigation than late maturing types. Work under the Indian Council of Agricultural Research since 1932 has produced a large number of improved varieties suitable to varying conditions such as flood resistant varieties for Bihar, flood and drought resistant varieties for Bengal, flood, drought and salinity resistant varieties for Orissa and deep water varieties for Bihar and Assam. Production of purple pigmented types for the wild rice infested areas of the CP, Sathi varieties for the gundhi bug infested areas of the UP and blast and foot rot resistant types for Madras and elsewhere are other achievements. Furthermore, the improved types gave higher yield than the existing indigenous varieties of the order of 17-23% in Travancore, 20-25% in Bihar, 30-52% in Orissa and 55-70% in Kashmir. But the spread of the improved varieties is estimated to be not more than 6% of the total area. If all the existing varieties of rice are systematically replaced by improved types, production could be increased at least by 10%.

(*c*) *Manure.*

It is well known that the Indian soils have been undergoing progressive impoverishment over long periods, and that the yield of crops will be stabilised at low levels unless manure is used to conserve and improve soil fertility. High yielding varieties, if they are to give the best yields, need adequate preparatory tillage, optimum watering and heavy manuring.

Thousands of manurial experiments carried out over many years indicate that Indian rice yields can be appreciably increased by suitable manuring. Manures, including such organic materials as green manure, oilcakes, compost night soil, etc. have been utilised to some extent in most of the rice growing tracts of India. The result of the fertiliser experiments shows that both organic manures and fertilisers must have an equally important place in any programme for increasing rice production in India.

Under high rainfall and high humidity conditions prevailing in our major rice tracts, the most suitable form of readily available nitrogen is ammonium sulphate, application of suitable quantities of which increased the yield by 15-35%. Rice plant needs phosphorus too and where this has been added either as bonemeal or superphosphate still further increases in yield has been obtained.

Our experience has also shown that green manure increases yields by 20% and when phosphates are applied to green manure crops there is an additional increase in yields by as much as 10%. Oil cakes and compost also gave similar results. Increases from manuring may range anything from 20-150%, according to the variety of seed, soil and climate and season. Where manures are known to be beneficial, the use of manures rank next to the provision of adequate supply of water as a means of increasing the output of rice per acre.

On the basis of our cattle population, all the farmyard manure produced should yield 8000,000 tons of nitrogen per year. Of this only 40% is at present used as manure, the rest is misused as fuel. By planting quick growing fodder-fuel trees as village plantations and with proper propaganda a considerable amount of cattle dung could be diverted for manuring our rice crop. Systematic composting of town and village refuse and waste materials can produce 200-300 million tons of good organic manure and should be taken up vigorously. We have about 1½ million tons of oilcakes (yielding about 75,000 tons of Nitrogen) of which we utilise now only about 0.8 million tons (40,000 tons Nitrogen) here again there is possibility for improvement. Extension of green manuring is limited by the lack of sufficient seeds and suitable mould-board ploughs for burying in the crop. This can be remedied by large scale multiplication of suitable varieties of seeds in our existing seed farms or by arrangement with reliable seed growers and an intensive drive for a large scale production of the ploughs. Green manuring however should be widely practiced where water is not limited as it is the cheapest manure for rice.

Though we require a minimum of a million tons of ammonium sulphate, due to world shortage we could import only 27,000 tons and 75,000 tons in 1947 and 1948 respectively to supplement our own production. We have also imported 10,000 tons and 25,000 tons of superphosphate in these two years.

(*d*) *Cultivation practices.*

Rice in India is cultivated as a monocrop year after year for decades, some times double and even treble crops being taken from the same lands, wherever irrigation facilities are available. No rotation seems to be practiced in most of the rice lands. A leguminous crop can profitably be made to rotate with rice crop.

(*e*) *Weeds and other pests.*

Weeds cause serious reduction in our rice production. Though data on the subject is very meagre, the available information is sufficiently impressive to make us sit up and take notice. In Malabar and elsewhere loss from the attack of the parasitic weed Striga on rice is considerable. Similarly, wild rice cultivation particularly in the C.P., Bihar and Bombay, where rice yields have been reduced by 5-30%. The loss it causes over 3.7 million acres of Biasi paddy in Chattisgarh tract in the CP alone amount to 2.2 million rupees annually. In Bengal alone, deep water paddy worth about 110 million rupees is supposed to be destroyed annually by the depredation of water hyacinth. Similarly the annual losses resulting from other pests and diseases affecting crop may average from 5-10% in a normal year, but under adverse conditions the losses may amount to as high as 50-75% of the crop in particular areas. At the same time, losses of rice in storage through the infestations of rodents, insects and other pests are estimated to be a million tons a year. These are easily remediable; powerful and specific pesticides are available in the market to control all kinds of pests.

(*f*) *Labour and power.*

Heavy wastage of man and animal power is almost a characteristic of Indian rice agronomy. Mechanisation of agriculture have been achieved by countries like the USA and Austrilia where rice farming is 100% mechanised and the yield from the land very high. But a majority of our holdings are small, lands heavy and low lying as such special light tractor and other implements may have to be specially designed for the purpose. However, where extensive medium loam lands are available and where human and cattle power are inadequate, mechanical cultivation should be attempted as feasible and profitable practice.

(*g*) *Land tenure and credit.*

Obsolete systems of land tenure, indefinite fragmentations and dispersal of uneconomic holdings which do not admit of scientific agriculture, expensive and dissolute habits and social customs, want of cheap and timely credit capital and equipment, widespread illiteracy and ignorance have resulted in most of the rice farmers living on subsistence level.

(*h*) *Marketing and prices.*

Since rice is grown in small subsistence farms, it is almost impossible to secure the advantages of large scale marketing in the absence of village cooperative societies. Rice producers share of the price of his crop in India, never go than 9 annas in the rupees. The Krishnamachari Committee in examining the question of price policy came to the conclusion that the guarantee of an assured market at a remunerative minimum price to the producer constituted the most direct and effective form of stimulating production. They also recommended that as a corollary to the fair price to the producer, the Government should regulate a fair price to the consumers.

(*i*) *Extension and propaganda.*

In India generally, yields obtained under field conditions are considerably less than those obtained on experimental plots. The Rice Study Group Trivandrum has suggested that one way by which rice yield per unit area could be increased would be through expanded and modernised programmes of adult education for farmers and establishment of rural youth organisations and clubs.

Conservation of rice is possible with better extraction of the grain from the paddy, compatible with the keeping quality and with a view to optimum preservation of the nutrient contents of the grain.

Raw rice can be undermilled and the scraping of the edible grain along with the removal of the bran could be considerably minimised in the process to the advantage of better extraction to an appreciable magnitude of 2-5%. The obstacles that stand in the way are, the difficulty of enforcing necessary mechanical adjustment in the existing milling machinery and the poor keeping qualities of under milled rice.

Parboiled rice on milling gives 6-10% more extraction than raw milled rice, stand storage conditions better, as well as conserve the essential food value of the grain. But here again distaste to the parboiled rice in another set of consumers, malpractices in the preparation and processing such as under drying and usage of unclean water for parboiling resulting in foul smell and taste in the cooked grain to the prejudice of even habitual parboiled rice eaters, and last but not the least, want of necessary standarised methods and equipment for the same for wider and large scale practice in the mills etc. are some of the limiting factors.

Calcuring, recently developed in India, consists of soaking rice in hot dilute solution of calcium chloride. The product called 'calcured rice" has all the appearance of raw, highly milled rice, possessing also the desirable features of the parboiled rice. It is claimed to be even less susceptible to insect attack than the other parboiled rices and supplies also calcium which is generally deficient in rice eaters.

GENETICS OF RICE:

DR. K. RAMIAH, Cuttack.

The basis of all breeding is selection, the material on which this is exercised can be introduction, natural populations or artificially created populations through hybridization. The success in breeding depends upon the soundness of the technique employed and the most effective and that which has given the most tangible results is selection in naturally variable populations. There are now over 200 improved varieties obtained by this method in different parts of India. This does not mean however, that hybridization has not been practised to evolve new varieties. There has been certain notable examples of improved varieties obtained by Hybridization also, particularly in Madras, Central Province, Bombay and Assam, though their number is comparatively small. These varieties have proved valuable more on account of improvement in ancilliary characters rather than in direct yield. Special mention may, however, be made of the most outstanding work in Madras in breeding varieties resistant to *Piricularia oryzae,* the most important diseases of rice. Breeding of special varieties with anthocyan pigment in the plant so that the wild rices which is a menace in the cultivated fields can be easily distinguished in the seedling stage and removed as in Central Province and Bombay and breeding of special varieties with a better quality of grain as in Bombay may also be mentioned in this connection. Breeding for resistance to rice ear fly has also been successfully attempted in United Provinces.

All breeding is based on the chromosome theory of heredity, according to which the genes present in the chromosomes control the various characters exhibited by the plant. Considerable genetical work on the rice crop has been done, and India has made a substantial contribution to this. The work here referred to deals mostly with genes having large individual effects on the plant body such as the occurrence of pigmentation, chlorophyle deficiencies, grain colour, endosperm character etc. Such qualitative studies now cover some 200 genes or so and 8 out of the 12 possible linkage groups.

Variations in plant character, however are not always sharply discontinous, but intergrade and range from one extreme to another. Characters of this kind involve difference in degree or quantity and are polygenic in nature. The analysis of polygenic characters is complicated as several genes act together affecting the same character. Special experimental technique and knowledge of statistics is required in resolving and interpretation of the data.

Until now at any rate in self fertilized crops-cereals it was thought once a superior plant was isolated by election in a natural population all the improvement possible was achieved and that there was no scope for further improvement by selection in its progeny. Correct breeding technique should be able to evaluate the effect of different environments on the different genetic characters associated with yield. At the Central Rice Research Institute selections were made in 10 improved and released rice strains and in 16 strains still under yield trials. Estimation of the genetic component of the progeny variation showed significant differences in 5 out of the 10 improved strains and in 3 out of the other 16 strains, thus giving scope for further selection in the material. The object of breeding cannot be achieved in one initial step, the material has to be worked upon and tested till the genetic variability is reduced to insignificance, this new concept of breeding requires statistical background in the training of the breeder.

The rice belt of the world can be divided into two distinct zones. The first comprising of Japan, Korea, North China, Italy and U.S.A. grows *O. sativa* var *japónica* and is reputed for the high acre yield obtained. The second comprising of India, Ceylon, Burma, Siam, Phillippines, Java, Malaya and South China grows *O. sativa* var *indica* and the yields obtained are very much lower than the Japonica area, though in small isolated parts of the second zone yields comparable to the former are also obtained. The rice growing season of first zone is characterised by long and sunny days with cool temperature, while rice season in the second zone is monsoonic coludy days and relatively high temperature. That the wide difference in yield of the two zones may be due to the climatic conditions under which the crop is grown in the two zones, gains support from the fact that the same variety of rice gives a larger yield in Kashmir than when grown in the plains. The variety, however, takes a longer time to mature there than in the plains. This comparison about Kashmir valley and the plains is with reference to the *indica* types only. It only shows that besides soil fertility and agronomic practices followed, climate does play an important part in determining yield. The *japonica* types when grown in the tropics are precocious and are extremely poor in yield. Rice has a low adaptability and is very sensitive to even small changes in day length and temperature. These physiological responses must have a genetic basis unless we are prepared to accept whole-sale the Soviet view of Genetical science. It looks reasonable to suppose that one way of genetic improvement in the tropical *indica* types should be to undertake an intensive study of the crosses between *japonica* and *indica* types. That this should be a hopeful method of improving the yield in Indian rices gains support from the fact that many of the successful varieties developed in U.S.A. are said to be selections from crosses between *japonica* and *indica* types. The work is not simple as it involves overcoming the problem of sterility to be found in such crosses. The work to give results should be undertaken in a sufficiently intensive scale and a correct technique followed in evaluating the progenies. Such an intensive programme of hybridization between the two races of *O. sativa* has been initiated at the Central Rice Research Institute. A very large number of crosses are intended to be made between the *japonica* varieties and the improved varieties of the various provinces and States suitably selected to cater for the varying needs of the rice growing tracts of the country. Selection in the F2 generation is intended to be made at the centres where the selections are to be grown.

In the field of genetics of physiological characters, such characters as duration (life period), lodging of the straw, shattering of the grain, spikelet sterility, etc., have been worked upon. Work in Madras has shown that it is possible to produce improvements in the above characters by suitable hybridization. The question of earliness or short period of growth should receive special attention. While the genetics of this character may be either simple or complicated according to the number of genes present in the particular material handled, there is no strict genetic association between duration and yield. Some of the highest yield obtained in India are not necessarily with the long duration rices. A three to four months crop grown in the right season and with manure can give as large yields as 400 lbs of grain per acre. In India rices vary in their life periods from 80 days to 8 months. The growing of a variety of a particular life period in mainly determined by climatic conditions, water facilities and agricultural convenience. There is no doubt that extra earliness, whatever other conditions may be, would be most welcome. Breeding for earliness is a simple affair.

There are other physiological characters like response to drought, flood, salinity and resistance to pathological diseases whose genetics are yet to be studied. Results of practical value *i.e.*, types resistant to flood and salinity have been obtained even by simple selection in India. So also varieties resistant to Piricularia by hydridization, but our fundamental knowledge of the above is still rudimentary. There is the question of species hybridization which is still an unexplored field in the case of rice. It is possible to change the position only by undertaking more intensive fundamental studies. Such studies may need a co-ordinated attack by a team of specialists like Geneticist, Cytologist, Pathologist, Physiologist and Statistician. It should be quite feasible to even send out promising hybrid material from one centre to different rice tracts for testing and further work in the respective tracts. There is also the question of breeding and whether such variation is to be found in vitamin contents also remains to be investigated. When this is done breeding for higher nutrition can be given a practical shape.

Genetics is a developing science and great progress is being made in it in other more advanced countries along with the development in the sister sciences of Cytology, Statistics, Taxonomy, etc. Though India has contributed substantially to the genetics of rice it may be said that this has been practically neglected during the last ten years and more. While there may be intensive breeding going on in different parts of India it cannot be forgotten that it is the development of the fundamental science of genetics that can give a correct lead to successful breeding.

Universities can give a correct lead by instituting chairs and undertaking teaching of genetics. So far Waltair is the only University in India that has introduced genetics as a special compulsory subject for the Honours Course in Botany. Research in genetical problem is one of the most important that is capable of producing practical results. Side by side with improvement in the teaching of genetics in the Universities and Agricultural colleges, facilities should be available to train research personnel.

Among the crops of India rice is easily the most important. It is the desire to have at least one centre where all aspects of fundamental research including genetics in this crop can be undertaken that has induced the Central Government to start the Central Rice Research Institute at Cuttack. It is hopped that it will be allowed to develop unhampered and prove a welcome addition to the several research institutes in the country. A large collection of breeding material from all over the world including wild species has been got together at the Institute. This material should be of great value for undertaking genetical studies as well as for breeding varieties of special characteristics.

Information available on improved strain of rice.

Bengal (undivided)	24.7	Dacca	20	4	1	25	1700 to 3400
		Chinsurah	11	–	–	11	2000 to 2900
		Bankura	15	1	–	16	1500 to 2500
		Barisal	2	–	–	2	2800
			48	5	1	54	
Madras	10.4	Coimbatore	17	4	–	21	2500 to 5000
		Aduturai	18	2	–	20	2000 to 4200
		Maruter	14	2	–	16	2800 to 4000
		Pattambi	16	–	–	16	1800 to 3000
		Berhampore*	9	–	–	9	2400 to 2800
		Samalkot	6	2	–	8	2200 to 5000
		Palur	2	–	–	2	3100
		Anakapalli	2	–	–	2	2500
		Ambasamudram	5	–	–	5	
		Buchireddi-palayam	2	–	–	2	
			98	10	–	108	

Bihar	9.5	Sabour	7	–	–	7	1830 to 2050
United Provinces	7.1	Nagina	17	3	1	21	2000 to 3400
Central Provinces	5.9	Raipur	14	5	–	19	1100 to 2000
Assam	5.4	Karimganj	19	3	–	22	1850 to 3840
		Titabar	12	–	–	12	1760 to 3200
		Habiganj	7	–	–	7	2480 to 3920
Orissa	5.1	Cuttack	20	–	–	20	2200 to 3200
Bombay	2.0	Karjat	4	1	–	5	2000 to 3000
		Ratnagiri	6	–	–	6	2100
		Mugad	7	–	–	7	2400 to 2700
		Kumta	3	–	–	3	
			20	1	–	21	

Sel. — strains evolved by selection in natural population

Hy. — strains evolved by hybridization

Intro — introductions.

*Transferred to Orissa on creation of the province in 1937.

THE CHEMISTRY OF RICE

Dr. A. Sreenivasan, Bombay.

The general make-up of the rice grain is well known and consists of the outer coat (the husk or glume), the perepheral bran layers (integuments) and the main body of the grain (endosperm) with the germ (embryo) at one end. Each of these parts has its characteristic composition. The husk or offal is mostly made up of resistant organic matter and has a high proportion of silica. The bran consists of three fibrous layers of pericarp, testa and aleurone and is rich in proteins, fats, minerals and vitamins. particularly vitamin B1. The embryo, constituting the scutellum plumule and radicle with epiblastic coverings, is also rich in nutritional ingradients. It has been shown from painstaking dissection and separation of the various layers and parts of the embryo, that the scutellum of rice contains 44-50 per cent. of the vitamin B1 of the grain, the plumule and radicle having another 9-12 per cent. The pericarp and aleurone layers together retain about 34 per cent. of the vitamin, the greater part being in the aleurone.

Carbohydrates predominate in rice as in all other cereals. Protein content is comparatively low and, like other cereals, rice contains only small amounts of fat and mineral matter, but the value of these is by no means negligible where rice for a good proportion of the total diet.

Despite the fact that rice varieties distinguish themselves by their yield, fineness of grain, milling quality, keeping and cooking properties, fitness to a variety of soil and climatic, resistance to pests and diseases and in various other ways, the average values for the different constituents, as reported by several investigators, fall, with few exceptions, within a narrow range. Between individual samples, however, the composition may vary somewhat widely. In particular, coloured and coarse varieties contain larger amounts of proteins and minerals, particularly calcium, phosphorus and iron, than fine-grained and white varieties which fetch the higher prices. The former also contain thicker aleurone layers.

A diet in which cereal predominates needs to be adequately supplemented with a good selection of other foods. While this is true of rice, it is worth considering here the intrinsic nutritional value of the rice constituents themselves

There is ample experimental evidence to show that rice proteins, small as they are in quantity (8-10 per cent,), are nutritively superior to those of wheat. Supplementation with skimmed milk or calcium lactate enhances greatly the nutritive value of the proteins of rice. The proteins of milled white rice are better represented in most essential amino acids than those of whole wheat. As compared to wheat, a serious deficiency in milled rice, on account of its lower protein content, is in respect of its lysine contribution. There is little data on the amino acid make-up of different rice varieties. It is possible that these may vary considerably; with waxy corn, for instance, lysine content could be increased through breeding.

Some varieties are fairly rich in phosphorus (0.75 per cent. P_2O_5) which is present mostly as phytin. Contrary to the view held that in this form it is not assimilable, it has been shown that it is not entirely unavailable. Rice is deficient in lime (0.07 per cent. Cao) and, in particular, the ratio of Ca to P is very unfavourable for their efficient utilisation. Hence, supplements of lime in the form of milk, vegetables and other foodstuffs will favourably influence their assimilation; leafy vegetables have a mineral ratio almost the reverse of that in rice and would therefore be an ideal corrective to this imbalance. Rice has only a small amount of iron (5-10 mag. per cent.) but its importance as a source of this essential constituent cannot be ignored in view of its high proportion in the rice dietary. It is noteworthy that many coloured rices contain nearly 2-3 times the amount of iron present in the commoner ones.

Rice oil is considered to be nutritious and is important as the carrier of vitamin E The oil is routinely solvent-extracted from bran in the U.S. and fractionated to give a wax, largely melissy ceritate, comparable to carnauba; is considered a highly valuable constituent of the bran and is really a 'by-product of a by-product, The keeping quality of the bran is also improved by fat extraction.

Rice, especially the bran layers, has long been recognised as a good source of the B vitamins, particularly thiamin. The thiamin, riboflavin, niacin, pantothenic acid, pyridoxine, and biotin contents of unmilled rice are 3-5, 0.8-1.0, 55-66, 17, 10, and 0.12 microgram per gram respectively. Rice also provides 0.5-1.0 I.U. per gm. of vitamin A.

The energy value in calories per 100 gms. for rice is 356 as compared to 362 for wheat. The average rice diet in India provides 2,000 calories per day with 477 grms. of rice and a total protein of 40 gms; these are low figures when compared to the recommended daily allowance of 3,000 calories with 70 gms. protein for an 'active' adult.

In growth experiments with young rats and pigeons using six rice varieties as the sole source of proteins and minerals in an otherwise adequate diet, the mean average weekly increase in weight per animal is highly correlated with the protein content ($r = 0.9608$; $P < 0.01$) of the varieties but not significantly with the phosphorus content ($r = 0.6910$; $P < 0.1$). In other work with fifteen rice samples, highly significant correlations are obtained between the average growth rate and the respective contents of nitrogen, phosphorus, and minerals excluding phosphorus. It is also noteworthy that, for the varieties examined, close correlation subsisted between the contents of nitrogen and phosphorus.

The various factors tending to lower the composition and food value of rice may be traceable to (*i*) the prevailing taste for fine, white, and small or long-grained varieties, (*ii*) the process of milling, and (*iii*) the practices of washing before cooking and of cooking in surplus water which is discarded subsequently. Undermilling, parboiling and enrichment have all been advocated as expedients to conserve or enhance the nutritional quality of the rice diet as ordinarily consumed. For the successful application in practice of one or all of these measures, it is necessary to take into reckoning the resistance to change in ingrained food habits and the widespread preference for refinement in food articles as well as, at the same time, the inherent difficulties in the adoption of technological features and technical controls that have been possible, especially in the U.S.

There has also been a general lack of effort in establishing a standard for control in degree of milling. Milling control by U.S. processors is effected by a chemical method wherein use is made of the fact that with the removal of bran there is concomitant removal of fat and a 10 minute extraction test has been developed. Photo-electric measurements are employed for colour comparisons while moisture control during milling is effected by using a meter in which the rice acts as the dielectric in a condenser.

Prevention of deterioration in storage also needs to be worked out especially as there are serious losses of vitamins and development of flavours. Perhaps an efficient means of overcoming the poor storage qualities of undermilled rice as also, incidentally, of minimising washing losses, will be to give the grain a superficial protective coat as in the artificial enrichment process. Stabilisation may also be possible by steam blanching and inhibition of lipase activity.

It seems unlikely that, except under stress of circumstances such as exist now, the average consumer will ever take to unmilled or undermilled rice in place of the milled article with its superior keeping and cooking properties. It is therefore to be regretted that there has been no planned long-range policy of nutritional improvement in rice that keeps this aspect in view.

Parboiling as a practical means of improving the food value of rice, especially after technological improvements and process control, is discussed elsewhere. The scope for artificial enrichment is also dealt with separately. It is important that rice processing should be so carried out as to ensure retention of most of the nutrient and vitamin contents. At the same time, it should be borne in mind that scientific endeavours in food technology has enabled the individual to look to his food as something which, besides supplying essential food ingredients, has an additional function in that it gives a feeling of well-being.

VITAMINS IN RICE.

DR. V. N. PATWARDHAN (Coonoor).

The consideration of vitamins in rice is restricted to B-complex group of these essential nutrients. Among these, thiamine deserves and has received the most attention. Some information is also available on the riboflavin and nicotinic acid content of rice, but that on the other minor members of the complex is extremely meagre.

The vitamins in rice are mostly found in the germ, scutellum and the aleurone layer of the grain. The endosperm contains these in small quantities. Hinton has found that the germ and scutellum together contain about 45-50 per cent of thiamine found in rice. The germ and scutellum are removed early in the process of preparing rice. This loss occurs only partly in dehusking but mainly so during handpounding or milling. The rice germ oil may contain some tocopherol, but very little is known about it. In this discussion, therefore, it will be necessary to concentrate our attention mainly to the rest of the grain. It is proposed to consider the question under the following heads:—

I. Vitamin content of varieties of rice.
II. Effect of storage of (*a*) paddy and (*b*) rice.
III. Effect of milling and handpounding.
IV. Effect of parboiling prior to milling.
V. Effect of washing and cooking.

I. VITAMIN CONTENT OF VARIETIES OF RICE.

As mentioned earlier there have been numerous analyses of rice for its thiamine content. Even then these are not exhaustive. In Table I are found the values of thiamine, riboflavin and niacin in several rice samples in India and the U.S.

TABLE I.

Vitamins in Rice u g|g

Type & Samples		Thiamine	Riboflavin	Niacin	
Brown (44)	..	3.55	0.60	53.08	Kik Williams 13 varieties U. S. A.
White (45)	..	0.84	0.26	19.62	
Brown (5)	..	2.9	—	—	Aykroyd et al—Med Res Mem. 1940—5 Varieties South India.
Brown (1)	..	4.0	—	—	
Handpounded (8)	..	2.4	—	24.0	
Machine milled (8)	..	1.0	—	16 0	
Brown (11)	..	2.1 to 4.8	—	—	
Husked Rice	..	—	—	46.0	Rao, Ramachandran & Rau. Swaminathan, M, 1944, 1942.
Handpounded Rice	..	—	—	24.0	
Milled Rice	..	—	0.30	12	

The thiamine content varies greatly from sample to sample. The highest value being 5 ug|gm and the lowest 2.4 ug|gm., although several of these rice samples belonged to some well known varieties, our knowledge about the factors influencing the thiamine content in relation to varietal and cultural differences is extremely meagre.

TABLE II.

Other vitamins in rice ug|g

Type & Samples		Pantothenic Acid	Pyridoxine	Biotin	
Brown (6)	..	16.4	10.3	0.121	Kik & Williams 1945. U. S.
White (3)	..	6.4	4.5	0.042	
Rice husked	..	—	6.9	—	Swaminathan 1940.
Rice raw milled	..	—	3.3	—	
Rice raw milled	..	—	2.3	—	Sarma 1944.

Table II gives the results of a few analyses for other minor members of the B2 complex. Here also it must be admitted that our knowledge is next to nothing.

II. EFFECT OF STORAGE.

Rice is usually stored after harvesting for varying lengths of time. It may be stored as paddy or as hulled and homepounded or partly milled rice. Storage of paddy is easier if it is kept in a cool and dry place, but the storage of dehusked rice is beset with difficulties as the grain falls an easy prey for microbial and fungal attack. The small amount of moisture and the large concentration of protein and fat in the germ provide a favourable nidus for growth of such organisms. The problem of storage becomes easier when the germ completely and the outer bran layers partly have been removed by suitable procesess.

(*a*) The opinion on the thiamine content of stored paddy is conflicting. Passmore and Sundararajan found that after a three months' underground storage there was a negligible loss in thiamine. Rao, Ramachandran and Rau found that paddy stored in bottles for three years on dehusking gave practically the same values for thiamine as they had done when fresh paddy was dehusked. On the other hand Chitre and co-workers in an unpublished report have stated that rice obtained from paddy stored in the Laboratory for three years had lost all vitamin B_1 it originally contained. Kix found that storage for nine months at 84°F caused a loss of 8 to 15 per cent in thiamine. On the other hand losses in storage for two-and-half years in cold storage were considerably less.

These contradictory results are probably due to different conditions of storage. Paddy is hardly stored for three years, but its storage for one year was not an uncommon practice before the days of food shortage. If one can dream of days of glut in rice production one will have to study the most effective methods of storage to prevent avoidable losses in vitamins of rice.

(*b*) The practice of storing shelled and milled or homepounded rice was also widespread in individual houses in rural and semi-urban areas.

Some information is available from the United States on the effect of storing rice in cotton bags exposed to the air at temperature 71 to 76° F for a period of three months. Brown rice lost 4 to 7 per cent and the white rice 5 to 12 per cent of its thiamine content.

III. EFFECT OF MILLING AND HANDPOUNDING.

A major portion of thiamine is to be found in the aleurone layer in general and the scutellum and germ as well. According to Hinton scutellum and germ contain 45-50 per cent of the total thiamine in rice When the rice is subjected to handpounding or milling the germ with its scutellum is lost and aleurone layer is removed partially or almost completely depending upon the severity of treatment and hence thiamine content of milled rice is considerably reduced.

Quite a good deal of rice in India is subject to milling. Extreme milling has been condemned by all nutrition and public health experts. The ingenuity and technical skill of the engineers should be utilised for production of milled rice of a satisfactory nutritive value. The Far Eastern Nutrition Committee of the F.A.O. recommended in 1948, that "it should be our object to produce milled rice which should contain not less than 1.8 ug|gm. thiamine." This can only be achieved by controlled milling. The losses during milling are progressive as can be seen from the following figures:—

	Thiamine ppm.	Loss %
Shelled rice	4.0	—
Once polished rice	1.8	55
Twice polished rice	1.0	75
Thrice polished rice	0.7	82.5

The above is probably an extreme example of the losses incurred in milling which vary from place to place, but losses between 70-80 per cent are not uncommon in milled and polished rice ready for the market. A majority of such samples contain thiamine in the neighbourhood of 0.7 ug|gm. In order to produce marketable rice of 1.8 ug|gm. B_1 particular attention will have to be paid to two aspects.

IV. EFFECT OF PARBOILING PRIOR TO MILLING.

Parboiling is a process which consists of steeping paddy in warm water for varying lengths of time followed by boiling or steaming till the rice grain is cooked within the husk. Paddy is then drained and spread out to dry. Dried paddy can then be hulled and milled or hanpounded. The product thus obtained is not always parboiled rice is consumed to a large extent in South India, along the West Coast and in Bengal. Efficient parboiling retains the vitamins in rice and milling losses are comparatively much smaller.

Aykroyd found that parboiled rice lost its thiamine on milling to a much less extent than raw rice. He suggested, therefore, that during parboiling the vitamins from the aleurone layers dissolved in steep water and penetrated the grain during steaming with the result that the vitamins were more uniformly distributed within the rice grain instead of being concentrated in the outer layers. A more rigid proof was provided by Hinton who analysed the germ, scutelleum, the outer endosperm and inner endosperm by a micro technique and demonstrated the redistribution of thiamine in the parboiled rice grain. Nicholls had earlier suggested that in parboiled rice scutelleum was more firmly attached to the endosperm and since the former was rich in thiamine, it was responsible for a greater retention of the vitamin in the parboiled grain. Hinton has shown that this is only partly true, redistribution of vitamin takes place even from the germ and scutellum to the endosperm which in turn becomes richer.

Not all forms of parboiling achieve the above desirable effect. Excess of water allowing condensation and leaching will cause not only destruction of vitamin but its removal from the grain. It is necessary, therefore, to standardize the procedure of parboiling so as to obtain uniform results. It has been found that even steeping for four hours at 75°C will achieve the object of redistribution of vitamin and better adhesion of scutellum to the endosperm, without causing much destruction of thiamine.

A patent process called "conversion" is a mechanized procedure of large scale parboiling where steam under pressure is introduced after first holding the steeped grain in partial vacuum. Redistribution of vitamins is achieved without appreciable destruction. This process has not been used in India.

V. EFFECT OF WASHING AND COOKING.

Finally come the losses on washing and cooking during preparation of rice for consumption. It is common practice to wash rice till one gets almost clear wash water. In the table below are given the losses, resulting from such practices.

Types & Samples of rice	Before Washing	After Washing	Washing and Cooking
	ug|g	ug|g	ug|g
Undermilled (Java)	1.5—2.4	0.8—1.2	—
Parboiled	0.6—1.2	0.6	—
Rice CO5 (India)			
Raw homepounded	2.5	—	0.6
Parboiled do	2.7	—	1.0
Rice CO7 (India)			
Raw homepounded (India)	2.3	—	0.7
Parboiled do	2.5	—	1.6
Raw Milled (U.S.)	0.65	0.37	—
Converted (U. S.)	3.02	2.82	—

Thus washing of rice reduces by nearly 50 per cent its vitamin content. Similar figures have been obtained with nicotinic acid also. It must be remembered that it is the first washing which is responsible for most of the loss. Therefore reduction of washing is not the solution to the problem of conservation of vitamins in rice. Parboiled rice loses comparatively less on washing than does raw rice.

Cooking in open pans is another cause of destruction of thiamine. In a double boiler the thiamine losses may be 1 to 6 per cent whereas in open vessel they may amount to as much as 57 per cent. Thus it is imperative to improve our methods of cooking if only to preserve what is left after washing.

In discussing the question of the conservation of vitamins in rice, it must be borne in mind that rice alone contributes by far the largest amount of thiamine and nicotinic acid to a poor rice eater. His diet is particularly deficient in protective foodstuffs and hence other sources of thiamine are denied to him. It is therefore far more important to attempt to conserve these nutrients in the cereal by recourse to suitable methods of processing. One can argue that with the knowledge and technical skill at our disposal it should not be difficult not only to restore the vitamin content of rice to its original level, but also it should be possible to enrich rice to a greater extent. It is true that the possibility does exist or that should resort to it in public interest. But that is no reason why the faulty practices responsible for so much preventable losses should be persisted in.

NUTRITIVE VALUE OF RICE DIETS

K. P. Basu, Bangalore.

The daily diet of majority of the people in India specially in Assam, West Bengal, Bihar, Orissa, Madras, and parts of Central Provinces, Bombay, Hyderabad, Mysore, Travancore, Coorg, Baroda, and Kashmir State is based on rice. The same is also true of the people of Southern China and South-East Asia.

Numerous diet surveys carried out all over India show that the composition of the typical rice diets is much the same throughout the country. About 65-75 per cent, and sometimes even more, of the total calorie intake per day (2000-2500), is derived from rice alone. In addition to rice, the rice diet includes only small quantities of pulses, vegetables and oils. The intake of milk and milk products is generally negligible. Fish and, also meat and eggs to some extent, are taken only in certain parts (Bengal, Assam, Orissa, Bihar and Malabar Side) and among certain communities (non-Brahmins in Madras, Mysore, Bombay) in the country. The daily intake of rice in normal times varies generally from 14 to 25 oz., of pulses from .5 to 5.0 oz., oils and fats from 1 to 3.0 oz., leafy vegetables from 1 to 3 oz., other vegetables from 1 to 5 oz., milk and milk products from 0 to 7 oz., meat and eggs from 0 to 15 oz., sugar and jaggery from 0.5 to 1.5 oz., fruits 0 to 2 oz., and condiments from 0 to 2 oz.

Chemical analysis has revealed that rice diets contain only about 50—55 gm. of vegetable proteins, very little of animal proteins, 8—10 gm. of fat, 500—500 gm. of carbohydrates, 0.2—0.23 gm. calcium, 1.3—1.8 gm. phosphorus, about 300—400 I.U. of vitamin A, 500 microgram of thiamin, 0.2 gm. of riboflavin and 10 gm. nicotinic acid and are very deficient. They suffer from deficiency of calcium, an unfavourable Ca: P ratio of 1: 6 which interferes with the utilisation of calcium which is already inadequate, deficiency of fats, and animal proteins and vitamins A and C and also of B group of vitamins specially thiamine and riboflavin. The deficiency of vitamin B1 (thiamine) would depend on the processes to which rice has been subjected viz., homepounding or milling, washing and the method of cooking. It has been reported that milling of husked raw rice results in a loss of 76.3 per cent of thiamine, 56.6 per cent riboflavin and 63.0 per cent of nicotinic acid. The effect of milling is to reduce the thiamine content of husked rice from 3—5 microgram to 1 microgram or even less per gm., and it has been reported that only 15 per cent of the thiamine present in milled rice remains after the rice has been washed and cooked by methods commonly used in India. The pantothenic acid content is, as a result of milling of rice, reduced from 17.0 micrograms|gm to 6.4 micrograms|gm and that of pyridoxine from 10.3 micrograms|gm to slightly less than half, 4.5 micrograms|gm.

In the well-known experiments of McCarrison who fed groups of young rats on the typical diets of different parts of India, the rats on the Madrasi and Bengali rice diets grew very slowly at the rate of 3 to 4 gm. per week and could not attain the size and weight of rats fed on the Punjabi diet based on whole wheat supplemented by liberal amounts of milk and vegetables. This showed that the typical rice diets of India were far from being balanced. Later investigators have verified the observation of McCarrison. The Report of the Soya Bean Sub-Committee of the Indian Research Fund Association mentions the results of experiments on the growth of rats fed on a typical rice diet of the common man in India and the same diet fortified by calcium and vitamins. The effect of supplements of soya bean and other pulses to the diet and the "fortified" rice diet was also studied. The typical rice diet caused very poor growth (0.75 to 3 gm. per week) in rats. The supplementation of pulses including soya bean led to some improvement suggesting that pulses are useful supplements to poor rice diets. The addition of calcium lactate and vitamins A & D (shark liver oil) and B vitamins (extract of dried yeast) to the typical rice diet very considerably enhanced its growth-promoting properties for rats. The inclusion of pulses in the "fortified" diet did not have any marked effect on growth. The Sub-Committee, therefore, felt that in typical rice diets in India, lack of adequate amounts of calcium and vitamins is to a greater extent the limiting factor than the lack of protein.

Recently co-ordinated experiments have been carried out at different Institutes in India under the auspices of Ministry of Food on the effect of a typical rice diet, alone or with various supplements like calcium carbonate, vitamins A, B Complex, & D and also casein (containing sufficient amounts of calcium), on the growth and reproductive ability of rats. This investigation which was carried out to see if hydrogenated vegetable (ground-nut) oils, m.p. 37° and 41°C, had any deleterious effect, revealed that growth and reproductive and lactating capacity of rats on the typical rice diet was very poor and that inclusion and nature of the fat had no marked effect. The supplements, specially the vitamins, produced a beneficial effect on the growth and reproduction. Whole milk supplement to the rice diet caused the best growth which was almost identical with the growth obtained on the stock diet. The reproductive and lactating capacity of rats on milk-supplemented rice diets was also normal. Milk can thus supply all the missing factors in the typical rice-eaters' diet. The nature of the milk—cow, buffalo, goat or sheep, inspite of the differences in composition, specially in fat content in which buffalo and sheep milk is considerably richer containing 7—8 per cent of fat, made very little difference.

Aykroyd and Krishnan also observed that school children getting only the typical rice diet showed much less gain in weight and in height than the group receiving in addition 8 oz. re-constituted skimmed milk. The beneficial effect of calcium lactate supplement was much less marked than that of milk.

The relative merits and the adequacy of typical rice and wheat diets in India have been studied by means of actual metabolism studies on human subjects. The rice diets consisted of 550-600 gm. of rice, 60 gm. of pulse, 70 gm. of fish, 200 gm. of vegetables and 30 gm. of mustard oil per day. In the case of vegetarian rice diets the fish was omitted and the intake of pulse increased to 100 gm. a day. The typical whole wheat diet was made up of 500-500 gm. wheat, 70-90 gm. pulses, 200 gm. vegetables, 50 gm. sugar and 30 gm. of ghee per day. The daily protein intake with rice and atta diets varied between 76 and 82 gm. and on both these diets the human subjects were in positive protein balance and retained considerable amounts of proteins. The digestibility and biological value of the mixed proteins of the rice diet were 80 and 60 respectively while the corresponding values for wheat diet proteins were 90 and 59. Thus the biological values of mixed proteins of both rice and wheat diets were found to be very nearly similar and the digestibility of wheat diet proteins was definitely better.

The story, however, is quite different when we come to the calcium content of typical Indian diets. Both the rice and the atta diets were very low in calcium. The rice diet contained on an average 234 mg. and the atta diet about 300 mg. of calcium, while the maintenance calcium requirement was found to be 432 mg. per day. On both the rice and wheat diets the adult experimental subjects were almost always in negative calcium balance or, in other words, they excreted more than they took. The deficit was more with the rice than with the wheat diets.

One of the most serious defects of both the rice and wheat diets in India is the deficiency of several vitamins which can be made up by the provision of adequate amounts of milk. Fresh green vegetables contain carrotene and their intake in sufficient amounts can supply the needs of vitamin A and also to some extent of vitamin C. Partial replacement of rice by atta, and intake of under-milled rice, preferably parboiled, will meet the requirements of B group of vitamins. The wheat diets are better in these respects. Infants and growing children in whom bone development is going on rapidly require supplies of vitamin D in the form of egg yolk, milk fat or fish liver ails (like col or halibut) or the synthetic vitamin.

There is nothing inherently bad in rice. It is the manner in which it is used to form the basis of a diet that is responsible for the poor quality of the common Indian rice diets. Firstly too much of rice is taken by the rice-eaters to the exclusion of adequate amounts of body-building and protective foods rich in proteins, fats, minerals and vitamins. Secondly the nutritive properties of the rice itself is very often decreased by the treatment to which rice is subjected before it is eaten. The adverse effect of milling, of washing the rice before cooking and of throwing away the water after cooking it with too much water—all these procedures remove a considerable part of valuable nutrients.

SYNTHETIC RICE

Dr. V. Subrahmanyan, Mysore.

The rice grain owes its great importance as an article of food to the following properties:—

(1) Its attractive appearance and neutral taste which permit of its being converted into a variety of food preparations;

(2) its ease in cooking and in digestibility.

The latter property is largely traceable both to its composition and to its grain structure. The grain is predominantly starcy and includes practically no fibre. The individual grains stand apart after cooking and thus facilitate the body juices to penetrating them easily. No other grain or tuber possesses all these properties to the same extent as rice. It should be possible however to reconstitute the same properties by suitable blending and processing.

Rice contains about 80% starch with about 8% protein which is of high quality. Such a blend can be obtained by suitable combinations of constituents from different grains and tubers. If, added to that, we could also reconstitute the grain structure in a suitable manner, we would be making available a subsidiary food product that would be fairly acceptable to rice eaters in general.

We have investigated the suitability of a variety of grains, tubers, pulses and other food materials for this purpose. We have found that maize is a good source of a starch which, on processing, behaves the same way as rice starch. Other grains like jowar and ragi are also useful if the presence of some slight colour is considered on disqualification. Even in the case of maize, the colour improves with the elimination of gluten, whereas if gluten is also included, the product is somewhat yellow in colour. The product obtained with or without gluten cooks very well and has been found to be quite acceptable to rice eaters. Tuber starches tend to soften on cooking with the result that it is difficult to preserve the grain structure. They are more suitable, however, for preparing products like sago which require very little cooking. That property will, in a way, be an advantage if attractive methods of every day usage can be devised.

For the processing of maize or jowar, the grain is first steeped in water containing sulphur di-oxide for two to three days till the skin softens to the desired extent. It is then washed and crushed with addition of fresh water. The resulting paste is then passed through fine sieves so as to separate the skin from the starch and gluten. The mixture of the latter can be either used as such or sent over tables so as to separate as much of the gluten as possible. The resulting product is then heated to about 50° for about 15 minutes so as to partially gelatinise the starch. It is then sent under pressure through perforated discs so as to obtain strands which have about the same thickness as rice. These strands are then mechanically cut into short lengths corresponding to those of rice grain and then dried at about 50°. Additional proteins such as those from pulses or seed cakes and minerals can be added prior to cooking the paste.

The above procedure when applied to tubers such as tapioca and sweet potato does not work satisfactory. The tuber starch cooks somewhat differently from rice starch and has a tendency to become soft and pasty on being cooked in the same way as rice. It is difficult therefore to preserve the grain structure which is much appreciated by the rice eaters. By combining grain starches with tuber starches, the processed product can be made somewhat stronger. Addition of proteinaceous materials such as seed cakes also imports some strength, but the resulting products are somewhat dark. The flavour is not also readily acceptable to rice eaters. In the case of tuber starches, the most promising approach seems to be that of converting them into sago-like products which are white and attractive and are therefore generally acceptable to rice eaters. Sago requires very little cooking. A soft and readily acceptable product can be generally obtained even by soaking the sago in an equal volume of cold water. This is of great advantage and the resulting preparations should become increasingly popular with rice eaters.

The preparation of sago from tapioca is well known. Tapioca Sago is already being produced in some parts of South India. The product as now produced is somewhat costly, but with increased production of tapioca and better methods of mechanization of the process, it should be possible to produce and to market the product at a price not exceeding between 3 annas and 4 annas a pound.

To prepare sago, the starch is first separated from the fibre by blending the tuber, sieving and settling. The starch which settles at the bottom is then partially dried and when it is somewhat most, is broken into a coares powder which is mechanically shaken in trays. The grains form automatically. As they do not have the desired strength, they have to be given some roasting so as to partially gelatinise the starch. When this is complete, the white sago which is the resulting product is ready for use.

The crude tapioca starch contains very little protein but contains a fair amount of calcium. The protein can be incroporated in different sources, but all the commoner forms of vegetable proteins impart a colour to be resulting product. The nutritive value is definitely improved by incorporating about 10 to 20% of groundnut cake. The experimentals animals which normally grow at 3 to 4 gms. a week on the poor rice diet grow at 8 to 10 gms. a week when groundnut supplemented tapioca sago is used in place of rice. The practical application of this finding is however somewhat difficult. Apart from the somewhat unattractive appearance of the resulting product, it will be extremely difficult to keep a check on the composition of the product if produced on a large scale by the industry. From the point of view of the consumer and also with the necessary control, it would appear to be desirable to fortify the sago only with calcium and to leave it to the consumers to supplement the protein from pulses and other sources.

Preparation of products like 'Macaroni', 'Spaghatti' will be acceptable to rice eaters, but such products may offer difficulty in regard to storage and transport. They may also prove to be somewhat costly. The consumers can themselves be taught to prepare such products out of different grains and tubers, and to use them in their own homes. Certain quantities can also be manufactured and marketed but these will have to be in packets which will have to be protected against spoilage.

Pending the discovery of any new method of processing, the best method of using the tubers would be to convert them into sago-like products which can stand storage and can be easily transported. The whole tuber flours can also be used for different food preparations but that will constitute only a limited application. As an additional food to make up for the deficiency of rice, a clean white sago-like product would appear to be the most promising. If such a product can be produced cheaply and plentifully, it will be a very useful subsidiary food that will at least partially make up for the deficiency of rice.

DISCUSSIONS

Mr. Sundaram, Madras.

He stressed the need of correct definition and standard of purity and quality for food articles. The name *Synthetic rice* given to this newly processed food would be objectionable in that it contravenes the provisions of the Food Adulteration Acts of this or any other country. The product be characterised as maize product, groundnut product, if necessary enriched maize product.

Dr. U. P. Basu, Calcutta.

The major cereal food of the country must be produced in quantity and quality. We will have to improve our production in the field and for this we will have to concentrate our energies in its various fields.

Further, the standards for rice as consumed must be fixed from authoritative samples of rice as produced from standardised paddy. Production of its substitute or materials for its fortification would be highly beneficial to the hungry million of the country. But for that we must look over the availability of the starting materials at economic price. But however, the main attention of the scientists in this country should be directed in the higher production of rice and not its substitute.

Mr. N. R. Verma.

Dr. Sankaran mentioned that the nutritive value of polished rice may be restored by adding the vitamin but there may be some essential substances that may be lost with the scutellum and the germ that may not be detected by the known method of chemical analysis. If that be so, how can the nutritive value of this polished rice be restored by adding the vitamins.

Mr. N. G. Apte.

In the course of preparation of synthetic we are losing 50% of food material of maize. Berfore further concentrating on this subject we should consider seriously about the loss of this food material.

Mr. S. G. Deshpande, Satara.

He enquired whether the artificial rice made out of maize is liked by the public in large, as maize is not liked by the public after turning it into bread as is done normally. If it is liked it is great contribution as some three years ago we could not dispose maize brought from America, as people did not relish it.

Mr. R. L. Sethi, New Delhi.

Tapico sago already being produced in large quantities and commonly sold in Northern Indian markets and consumers are taking to it in the absence of genuine sago. If for the production of the new grains resembling rice, double the quantity of maize or other millests are required then it is not a sound economy.

Dr. N. R. Bhat, Poona.

Mr. Ramaiah stated that the Fisherian School believes that the Statisticians alone do geneticall work. His later statements did no support his earlier remarks. For, he stated that he had undertaken experiments on the lines on which Dr. Pars had worked. Probably, what he meant was that major genes have a great relo to play in heredity. His own work on an important character like fouring has shown that only a few major Genes were responsible for the character. Dr. R. L. Knight has also sufficiently emphasised the role of Major Genes. However, one cannot help nothing that important economic character, *e.g.*, Yield are governed by minor Genes. What the Fisherian school feels is that the statistician should prove a great aid to the geneticist in handling such characters if the latter does not know statistics and not that the satistician can take his place.

Dr. V. Subrahmanyan, Bangalore.

Thanked Mr. K. V. Sundaram for his suggestion and stated that a suitable proprietory name could be thought of when the product is placed on the market. In reply to Dr. Basu, he stated that the comparatively low production of starch in the country is not due to the poor capacity of the existing factories. The potential capacities of the big factories alone are more than the total requirement of the textile and other industries. One single factory in Ahmedabad alone is capable of producing about 60 tons of starch per day. The bottle-neck is the availability of maize or other grain for the manufacture. The Government is not releasing much maize for starch manufacture as the grain is mostly required for food. Replying to the remarks of Dr. Mitra, he stated that in dealing with subjects of this type, the scientists need not always be actuated by motives of gain. The satisfaction of doing something that may be useful to the country in an emergency should itself be an incentive to intensive effort. Judging from the trends, the country will soon have to face a serious situation, especially in regard to rice, and it would be a good thing to be prepared well in advance. In answer to Mr. Apte, he stated that researches in the field of subsidiary foods such as the one on synthetic rice would not have been necessary if the country can produce more grains to meet its needs. Such a production has not been realised in spite of the efforts made from various directions. It will be doing positive dis-service to the country if efforts for producing useful substitutes are discouraged. There is a great deal of talk about producing more food and more milk, but very little has actually been achieved. It will therefore be only practical wisdom to support scientific effort leading to production of acceptable forms of substitute foods. He further remarked that there was a general tendency among both scientists and laymen to decry new efforts, but such a tendency was harmful not only to the efforts concerned but also to the country as a whole. He narrated the instance of the difficulties that he had in developing compost research during the early days of the War. If he and Dr. C. N. Acharya had not persisted in the face of continued opposition and discouragement, the country would not have seen the present development. If today we are producing a few hundred thousand tons of extra manure as compost and if that is helping to produce about a million tons or more of extra food in the country, it was because of the earlier efforts in the field. All new efforts need not become practical successes, but if even one succeeds, it will be something which both the workers concerned and the country could be proud of. In reply to another query, he stated that if the slightly yellowish product incorporating the gluten is prepared, the return of finished product will be about 80% of the weight of maize. If the gluten is partially eliminated to obtain a comparatively white product, the yield will be 60 to 70% of the weight. Answering a further query, he stated that the yield of an attractive white product from tapioca is about 25% on the *fresh* weight of the tuber. If crude tapioca flour is used, the yield will be a little more. One a comparative basis tapioca yields more dry matter per acre than rice, so, without any major alteration in our agricultural practice, we could get very much more food per acre if we grow tapioca in place of rice. If, together with this, we can process the tuber to yield a product acceptable to rise eaters, it will be an effective method of meeting our immediate shortage.

CONCLUDING REMARKS BY THE CHAIRMAN

DR. K. MITRA, New Delhi.

He had expected that Dr. A. Srinivasan would say something on the cooking quality of stored and unstored rice. Well stored rice has capacity for swelling on cooking with water whereas new rice imbibes very little water and cooks to a paste. One has often heard of complaints, about indigestibility of rice cooked to a pasty condition. It was Dr. Srinivasan and his colleague who had, about 12 years ago, shown that amylohydrolytic enzymes do not digest rice properly when it is cooked either in lumpy or pasty condition. Synthetic rice of Professor Subrahmanyan is an interesting venture in the field of food technology but it does not appear to help very much in these days of food shortage. Finally he expressed his gratitude to the various speakers who had taken part in the symposium.

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